THURSDAY, JULY 2, 1885

TWO BOTANICAL TRANSLATIONS FROM THE GERMAN

I. *Text-Book of General Botany.* By Dr. W. J. Behrens. Translation from the Second German Edition. Revised by Patrick Geddes, F.R.S.E. (Edinburgh: Young J. Pentland, 1885.)

II. *A Guide for the Microscopical Investigation of Vegetable Substances.* From the German of Dr. Julius Wilhelm Behrens. Translated and Edited by Rev. A. B. Hervey, A.M., assisted by R. H. Ward, M.D., F.R.M.S. (Boston: S. E. Cassino and Co., 1885.)

I. A STUDENT of science in our Universities on running his eye along his bookshelves can hardly fail to be struck by the large proportion of translations which find their place there; in physics and in chemistry the proportion of them is large, but in biology and especially in botany the original productions of this country hardly hold their own against their foreign competitors. It must be freely admitted that there was a time, not long ago, when botanical laboratory work had fallen to a low ebb in England; the botanists of this country had failed to keep pace in this branch of their subject with their contemporaries on the Continent, and it was chiefly by the translation of the text-book of Sachs that laboratory work received a new stimulus on this side of the Channel. The translation of that work some twelve years ago has been followed by others of standard books, and we have reason to expect that their number will be further increased within a short period. Any reasonable person will welcome the translation of standard and classical works; their production is beneficial, and they may at times even bring about wholesome revolutions. But though the most important translations produced recently are from the German, it does not necessarily follow that all German text-books are good, and the first of the two books above named is an illustration of the truth of this.

Perhaps the greatest difficulty in the construction of an elementary text-book which aims at the general treatment of a science is suitably to balance the several parts of the subject, bringing out at length those parts of the science which are important to elementary students, and placing in the background those branches which are of less importance; it is on this rock that writers of text-books have most often split, and this text-book of Dr. Behrens is no exception. But it is also essential that a text-book shall be accurate in its facts; it will be seen from the quotations below that Dr. Behrens's book fails repeatedly in this respect.

The external morphology of the higher plants, including the structure of the flower and the principles of classification, occupies the first 160 pages; the treatment is neither better nor worse than that usual in text-books of the present day. Then follows, under the head of "Physiological Botany," an exposition of 70 pages in length on "flowers and insects," and transport of seeds. Anatomy and physiology judiciously welded together occupy 80 pages, while the whole series of "Lower Plants," including the Vascular Cryptogams, are dismissed in less than 40 pages, barely half of the space devoted to "flowers and insects, &c." If we take a rough estimate of the balance of the book by the number of pages devoted to the several branches it is clear the lower plants come off the worst, and a quotation will illustrate the result. On page 332 the following is the whole account given of the Florideæ:—"The Florideæ are sea-weeds containing red or brown colouring matter. They are distinguished from the sea-wracks by the circumstance that their spores are generated in capsules (cystocarps, *f*, Fig. 390), which arise in the axils of the leaf-like lobes of the thallus (*s.d*)." Then follows a short description of *Batrachospermum*. Not only is this description insufficient and useless to a student, but it is also obviously inaccurate. Of the other inaccuracies a few may be cited. In Fig. 371 the pit-membranes in the wood of *Pinus sylvestris* are altogether omitted; the flattened stems of *Phyllocladus* are described as leaves in the explanation of Fig. 408, notwithstanding the tall talk on morphology on pp. 237-8. On p. 350 we read: "In the highest Cryptogams only are the sporangia formed by leaves, or homologues of leaves; in the Phanerogams this is always the case;" and, on p. 101, "as *all* Phanerogams have either one or two seed-leaves, &c." The above quotations by no means exhaust the inaccuracies of the book.

In not a few cases statements are made which can only confuse the student. Thus on p. 352 we read: "In the Metasperms the two generations of the vascular Cryptogams are represented by one." And again, on p. 314, "Spores are entirely destitute of an embryo, having plumule, radicle and cotyledons." A man who can write such sentences shows that he is not in sympathy with the student.

Perhaps the most prominent error in the book is one of omission. In describing the stomata a special paragraph is devoted on p. 283 to their function, but not a word is said of transpiration; on turning to the description of transpiration on p. 305 the stomata are not mentioned! And this is a book which aims, as stated in the preface, at placing the student "at the newest standpoint of the science"!

Enough has now been said to show that the book is far from being a model text-book; but it must not be concluded that it is entirely without merit; many of the illustrations are good, and the exposition is for the most part clear, while historical notes interspersed here and there in the text lend additional interest. It is, however, obvious that neither in point of accuracy nor of balance is the book so near an approach to the ideal elementary text-book as to merit the honour, or deserve the trouble of translation.

The above notice has been extended to greater length than the importance of Dr. Behrens's text-book deserved, because the publication of this translation marks in a certain sense an epoch in the progress of botany in this country. For the last twelve years we have been dependent in great measure upon Germany for our larger text-books; we have in that respect been leading a parasitic existence, or rather passing through a period of *healthy symbiosis*, such as that of the embryo on the parent plant; the time is fast approaching when we may expect the young plant

to assert its independence, when text-books designed to meet our own peculiar requirements shall be written by native authors. Meanwhile let the choice of books for translation be confined to those that are sound and good, let us guard jealously against any tendency to a *saprophytic* habit, with its attendant degeneration; the translation of an unsound text-book may be regarded in a sense as marking a saprophytic tendency, and the appearance of the translation of this book of Dr. Behrens is perhaps the first indication of such a saprophytic habit.

Lastly, would it not be possible, and much more advantageous, to transmute the energy now devoted to translation into original production? It is admitted that a teacher acquires both facility of exposition and clearness of view by writing down his ideas in the form of a text-book. It is for us to see that we do not continue our "healthy symbiosis" unduly, and thereby lose that power of original exposition for which so many English men of science have been properly celebrated.

II. The second work under review is a translation of a book by the same author, and it is one of those works now being produced in rapid succession which aim at assisting the student in his practical work in the laboratory. The keynote is struck by the following passage from the preface to the German original: "For a work to be useful in those microscopical inquiries which are most important in the botanical laboratory, it need teach neither optics nor histology." It may fairly be admitted that within the cover of this book the student will find clearly laid before him all that it is essential he should know of the theory and structure of the modern microscope, together with useful instructions as to the methods and reagents in use in the botanical laboratory. Dr. Behrens boldly challenges criticism in his preface, when he says "the chapter of this work which deals with the microscopical investigation of vegetable substances furnishes an *exhaustive* treatment of these matters." Whatever may be our opinion as to the correctness of this statement it must be allowed that the work now before us is the result of an earnest effort, and represents wide and laborious sifting of a scattered literature not easily accessible to most students. There is quite a pathetic ring in one sentence in the preface; referring to the literature of the subject in the University Library at Göttingen, the author says: "With hardly a noteworthy exception, I have seen and read it all." It is only those who know how voluminous and how scattered are the writings on this subject who can form an idea of the magnitude of this task.

The first two chapters, dealing with the microscope and microscopical accessories, have been subjected to considerable alteration and extension by the editors. Naturally German stands and objectives are not so accessible in America as those made on the spot; the editors have devoted considerable space to the description and illustration of the microscopes of American manufacture, so that this part of the book partakes, both in appearance and contents, of the character of an optician's catalogue. A few paragraphs have been added on the subject of "nose-pieces;" but there is no mention of that invaluable nose-piece of Zeiss which is calculated to save the time of workers in no small degree—viz. that which can accommodate four objectives, and on which the tubes carrying the objectives are cut of such length as to bring each in turn approximately into focus: the value of this arrangement is obvious.

Chapter III. contains useful directions for the preparation of microscopic objects, cutting sections, mounting, drawing, &c. The most important part of the book, and that which will assuredly be the most generally useful, is that comprised in the last 200 pages, and it is almost a matter of regret that this latter half has not been published separately from the first 260 pages, which have an interest chiefly for the beginner, while for the advanced student they will be little better than lumber. Pp. 267-311 are devoted to the enumeration and preparation of micro-chemical reagents, while Chapter V. deals with the microscopical investigation of vegetable substances. It is to be noted that no reference is made to the inventor of chlor-iodide of zinc beyond his name, which, according to the notice of the meeting at which his solution was first described ("Flora," 1850, p. 643), is spelt "Schulze" not "Schultz" as it stands in the text. There is no mention of the demonstration of protoplasmic continuity, even in sieve tubes, nor is the substance of the "callus" of sieve tubes or its reactions described. These omissions do not greatly affect the value of the book; they would not have been mentioned had not Dr. Behrens professed to give us an "exhaustive" treatment of the subject. One chief merit of the work is that copious references are given to the sources from which Dr. Behrens has drawn his information; this will greatly add to its usefulness, and the translation may be accepted as a valuable addition to the laboratory handbooks already before the English-speaking public. F. O. B.

RUSSIAN CENTRAL ASIA

Russian Central Asia, including Kuldja, Bokhara, Khiva, and Merv. By Henry Lansdell, D.D. (London: Sampson Low and Co., 1885.)

DR. LANSDELL, already favourably known to the public by his interesting volumes "Through Siberia," gives in the present work a mass of information on a subject to which the attention of Englishmen has of late been perforce directed—the Russian dominions in Central Asia. In the two goodly volumes recently published he gives the narrative of a journey undertaken in the year 1882, in the course of which he traversed Kuldja, Bokhara, Khiva, and Merv. Turkistan has been rarely visited by Englishmen, and, as Dr. Lansdell believes, in certain parts he may claim to be the first. The principal object of his journey was a philanthropic one—the distribution of religious literature, especially in the prisons of the Russian empire; but in writing this book he has kept in view the requirements of students as well as of general readers, providing for the former by touching upon the "geography, geology, fauna and flora, the characteristics of the people, their government, language, and religion"—to which not only numerous notes but also whole chapters are devoted, as well as "appendices, derived from works only published in the Russian language, which treat on the fauna and flora of Turkistan."

It would be impossible in the space to which this notice must necessarily be restricted to give an adequate

idea of the great amount of matter which Dr. Lansdell has collected in these two volumes, so that we must content ourselves with a brief glance at a few of the more salient features.

To geographers the account of the Thian Shan Mountains will be among the subjects of interest. These mountains, estimated by Réclus as forming a mass twenty-five times larger than the Swiss Alps, and a protuberance on the earth's surface larger than the united mountains of all Europe, begin in Mongolia, and develope by the addition of successive ridges until they occupy from north to south above eight degrees of latitude. The heights of the several ranges vary from about 10,000 to 14,000 feet above the sea, and in the Pamir range exceed 15,000. The number of glaciers exceeds 8000. The principal lakes are the Alakul, the Balkash, and the Issikul, the waters of which are brackish; the first and second are believed to have once been connected. Volcanoes have been stated to exist in the Thian Shan, but this appears to be incorrect. Much information of interest is given about the Ili Valley, a meeting ground of the Tatar and Mongol races. From this region Dr. Lansdell diverged eastwards from the course of his journey to reach Kuldja, a town within the Chinese frontier, for some time in Russian occupation. He then continued his journey in a westerly direction, passing through Semirechia, of which region he gives many particulars of interest, dwelling especially on the patriarchal life of its nomad inhabitants. From the Kirghi Steppe he passed into Turkistan. The climate of portions of the Aralo-Caspian region does not appear inviting: the summer temperature is from 68° to 77° F., the winter from 5° to 23°. In the lowlands rain falls rarely in summer, and in only a small amount at any season. Hence there is a general desiccation. The beds of tributary rivers are dry; the main streams lose themselves in sands or terminate in brackish marshes; the smaller lakes have evaporated, leaving behind them beds of salt; the larger are much reduced in size. The land is barren; trees are scarce; vegetation is stunted, and limited in its species. The geology, as might be supposed, has not been exhaustively worked, but from a small work of M. Mouchketoff the author has obtained an outline, from which it appears that in one part or another of the district almost every formation, from the oldest to the newest, is represented, and that the mountain-chains consist largely of igneous rocks.

Dr. Lansdell spent some days in Bokhara, which town no English traveller had visited since the time of Wolff's adventurous journey. The fear of the Russian is, however, now upon this people, and he appears to have met with little difficulty, though subjected to some surveillance. On his way to the city he visited the Emir, then at Kitab, and had a gracious reception. The description of the author's invention of a court costume for the ceremony of presentation is amusing: the chief components were a cassock, a D.D. hood, some masonic jewels, and a square college cap. From Bokhara Dr. Lansdell travelled through Khiva, and thence by a rarely-traversed route, which, after following the general direction of the Abu-Daria for some distance, runs in a west-south-westerly direction to Krasnovodsk, near the Karaboghaz Bay of the Caspian. Thence he returned to England, having accomplished in 179 days a journey of 12,000 miles—laborious, with considerable hardships, and not without some danger, though the Russian influence has rendered many places, formerly all but inaccessible, comparatively safe.

Dr. Lansdell does not profess to be a scientific traveller, but he is a careful observer, noting with an experienced eye the physical peculiarities of the regions through which he travelled; and he has been at immense pains to gather together a large mass of information concerning the flora, fauna, and ethnology of Central Asia,[1] which has been to a great extent accumulated by Russian men of science, and which, from being written in their language, is practically inaccessible to most Europeans. The appendices on the flora and fauna of Russian Turkistan occupy 148 pages of rather small print, and there is in addition a very full bibliography of the same district which extends to twenty-five pages. But much information, both from books and from personal observation, is also incorporated into the narrative of travel. Dr. Lansdell's picture of the desiccation of the western part of Bokhara, of the moving sands between the Oxus and the Karakul, of the "barren and dry land" of the Aralo-Caspian region, and of the Karaboghaz Gulf—a great area of evaporation which, should any physical change close its narrow and shallow communication with the Caspian, would soon become one vast salt-pan—cannot fail to interest the student of physiography. In a word, the ethnologist, geologist, and naturalist will find these volumes not only very pleasant reading, but also most valuable for reference.

OUR BOOK SHELF

Bulletin of the Bussey Institution. Vol. II., 1884. (John Allyn, 30, Franklyn Street, Boston, U.S.)

THE *Bulletin* of the Bussey Institution has many claims to be considered as original in its design and in the character of its reports. It contains a large amount of information upon out-of-the-way topics, mostly treated upon from the chemical side, and in all cases communicated by Prof. F. H. Storer, Dean of the Institution, and Professor of Chemistry.

The Bussey Institution is apparently a branch of Harvard University, having special endowments, and its objects comprise the teaching of young men intended to become practical farmers, land agents, gardeners, florists, or landscape gardeners.

The investigations conducted by Prof. Storer, reported in the *Bulletin* before us, are highly interesting to such students, and are characterised by a keen practical bias. The first paper is devoted to results of analysis of the leaves of *Rumex crispus* and the common milk-weed (*Asclipias cornuti*), with a special view to their economic value. The second paper is upon an ingenious plan of ascertaining the rate at which various fertilisers may be scattered by hand, or, in the Professor's own language, "about how much of a given fertiliser would a man naturally throw from his hand in sowing an acre of land?" Surely no learned professor ever set himself a more homely task! Next we find "Experiments on Feeding Mice with Painters' Putty and with other Pigments and Oil." This is almost revolting, and raises a feeling of pity for the mice, together with a certain sense of loss of appetite on the part of the reader if he is indulging in an ante-prandial study of scientific novelties. Mice, however, *do* eat putty, and, more curious still, red lead

[1] See an article by Dr. Lansdell, NATURE, May 21, p. 56.

mixed with putty, without injury. They thrive on the linseed oil used in the manufacture of this most unsavoury side-dish and the whitening which forms the other ingredient of "pâté de putty" seems to neutralise the evil effects of the lead. The bearings of these facts are important from a sanitary point of view, as Prof. Storer shows that the effects of mice eating away the packing of valves, of drains, and closets is an immediate frustration of the best efforts of plumbers and sanitary engineers to keep human habitations free from sewer gas. Not content with mice, the Professor tried similar experiments upon rats, when it was found that "rats when kept upon a rather short allowance of oats, ate putty freely. Finally "the surviving rat was fed with 'plain putty' for a day or two, after which he received and ate (poor wretch) each day for two days a ball of putty made with a mixture of equal parts of slaked lime and whiting. He was next given a ball of putty made from a mixture of one part of oxide of zinc and three parts of whiting, together with 2½ grammes of oats, and although he ate very little of the ball he died soon afterwards." The chief result of these experiments appears to be the injury rats and mice may do to houses and the curious protecting effect of whitening as an antidote to such active poisons as red and white lead and carbonate of baryta. Experiments upon the germination of weed seeds and a special instance of the resistance of clover seeds to water form two very interesting notes bearing directly upon well-known phenomena often ascribed by the ignorant to spontaneity of growth. The extraordinary irregularity of periods necessary for the germination of certain weed seeds is very clearly shown. "Of 400 seeds of shepherd's purse (*Capsella bursa pastoris*) three germinated on the fifth day and three on the seventh day, then none until the 145th day, when four germinated. Seven seeds germinated on the 1173rd day, or after an interval of about three years and two months—in all 18¾ per cent. to that date." Many similar cases are cited. Another article is upon "cherry stones eaten by domestic pigeons," which appears unpromising, but is rendered interesting by this versatile observer. Prof. Storer is evidently a man who is not likely to allow any natural phenomenon to pass unnoticed.

JOHN WRIGHTSON

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Clifford's Common Sense of the Exact Sciences

It does not seem to me necessary to reply to the charges made against Clifford by Prof. Tait in your issue of June 11—charges which, when freed from "mystery and insinuation," amount to accusations of plagiarism and inaccuracy—for Clifford's reputation is unlikely to be in any way affected by what Prof. Tait may write. But I do feel it necessary to make a remark on the last paragraph of his review. He therein accuses me of "mystery and insinuation," weapons which should not be employed in connection with Clifford's name. He does not do me the scant justice of publishing the footnote on which he passes these strictures. That footnote runs as follows:—

"A still more serious delay seems likely to attend the publication of the second part (*kinetic*) of Clifford's 'Elements of Dynamic,' the manuscript of which was left in a completed state. I venture to think the delay a calamity to the mathematical world."

When I wrote the footnote, I knew—

(1) That the manuscript was in existence, a fact with which any one who had examined the bibliography attached to the mathematical works must have been acquainted.

(2) That this manuscript, unlike that of the "exact sciences," had not at that time found a publisher, and therefore was more likely to be seriously delayed.

(3) That the mathematical world had been so far forgetful of its own interests as to raise no demand for its publication.

My note was written with the express purpose of recalling the attention of those who valued Clifford's work to the existence of this manuscript, in order that a general demand for its publication might produce a publisher. Those who find "mystery or insinuation" in this, or in whom this can "strike a jarring chord," must be singularly constituted individuals. The note had on the face of it an obvious purpose; that purpose, I am happy to know, it has to some extent helped to accomplish.

University College, June 12 K. P.

On "K. P.'s" note, which has been communicated to me by the courtesy of the editor, I desire to make one or two remarks.

In writing my notice of Clifford's book I endeavoured to state clearly the impression which its perusal had produced in my own mind, and to say a few fitting words as to the special qualifications of the author. I must have sadly failed in this endeavour if in what I have written there can be found either mystery or insinuation, still more so if there can be found "accusations of plagiarism and inaccuracy." But of course even an Act of Parliament has to be construed after the letter, the declared intention of its framers notwithstanding. On reperusing my notice, however, I still think that it expresses what I meant to say, and that it cannot bear the construction put on it by "K. P."

The remarks I made on the foot-note to the Preface accurately described the impression which it produced on me, and which I am sure it is likely to produce on the majority of thoughtful readers. So strongly did I feel this impression that, when I finally returned my notice for press, I specially requested the editor to try to obtain for me an elucidation of the mystery. This has been—in part at least—supplied by Mr. Tucker's note.

Whether "R.," who writes in NATURE of this week, be really a "(so-called) metaphysician" or no, he certainly expresses himself in the language of that school; for he mildly characterises as "not sufficiently guarded" the statement that a figure, obtained in a certain way, will be a cube:—whereas it obviously may be any rectangular parallelopiped whose edges are commensurable. But I did not blame Clifford for having made this statement; I merely said that it "ought not to have escaped correction." Perhaps even that expression is too strong. I have lately learned by experience that over-zeal on the part of a press-reader may sometimes render abortive the most sedulous care on the part of an author. Over and over again I have had proof-sheets, marked "*press*," returned to me with a learned query at the phrase "feet per second, per second"; and in one or two instances the supposed blunder has been *rectified* after all in spite of me. P. G. TAIT

June 26

Recurrence of Markings on Jupiter

In connection with my remarks on this subject (NATURE, xxxii., p. 31), and the suggestive coincidences which appear amongst certain drawings obtained in about the years 1857 and 1859, 1870 and 1872, and 1885, as to large elliptical markings in the southern hemisphere of Jupiter, I would further add that in about 1843 a remarkably large spot was visible, which may possibly be connected with the phenomena of more recent occurrence. Prof. Piazzi Smyth mentions in the *Observatory*, vol. iii., p. 450, that, in consulting some old observations preserved in the note-books of the Rev. H. C. Key, he found "a view of Jupiter, with not only the dark belts admirably drawn, but between them, in stronger black colour, a long oval spot. This spot, too, was so precisely the shape and size of the red spot which has of late been attracting the surprised attention of observers, that I could not but jump to the almost self-evident conclusion of their both referring to the same body, appearance, or phenomenon." The drawing alluded to was made on June 4, 1843, and Mr. Key described it as a "horizontal black spot in the light space between the two principal belts." In Chambers' "Descriptive Astronomy" (2nd ed., p. 107) it is stated, "In 1843 a very large black spot was observed by Mr. Dawes," and this object is doubtless identical with that figured by Mr. Key. It will be important to compare the observations and to learn whether these spots were situated in approximately the same latitude as the red spot of our own time.

The latter has been growing much darker and more conspicuous during the last few months, and it seems very probable that this object may resume a good deal of its former prominence during the opposition of 1886. With my 10-inch reflector, power 252, I recorded the spot as passing the central meridian of Jupiter on June 26, 1885, at 7h. 59m., and to-night, June 28, at 9h. 37m. A comparison of these times with the earliest I obtained during the present apparition (1884, September 21, 18h. 28m.) shows that in the interim of 279d. 15h. 9m. the spot has completed 676 rotations with a mean period of 9h. 55m. 39·0s., which is almost identical with the periods found during the two previous oppositions—viz. 9h. 55m. 39·1s. But I am hoping to obtain another observation of the spot before the planet leaves us for the season. W. F. DENNING

Bristol, June 28

Occurrence of "Torpedo Marmorata" off the Coast of Cornwall

AMONG the fishes included in the British fauna, but whose title to this designation has been considered but doubtfully proved, is the *Torpedo marmorata*, or a form having the spiracles fringed at their edges. It is true that Pennant figures this species, but he omits to mention whether his example was from the British seas or brought from the French coast by Walsh; and subsequent authors on ichthyology are not sufficiently precise in their descriptions to enable one to judge of which form they are adverting to. All the specimens which I have seen in the various British museums have been of the cramp fish, with smooth-edged spiracles, *T. nobiliana*. On June 26 an example of *T. marmorata* was trawled in Mevagissey Bay, and obtained by Mr. Matthias Dunn, who most kindly sent it at once to me, and it arrived at Cheltenham on the evening of the 27th. It was a female, quite fresh, and weighed 3 lb. 10 oz.; its length was 17½ inches, and its breadth across the disk 12 inches. It contained two ova in an early stage of development. FRANCIS DAY

Cheltenham, June 27

Composite Portraits

IT is always desirable to guard new discoveries and inventions by explicit investigation of the nature of the facts discovered and the mode of action of the invention.

The system of composite portraits ingeniously invented by Mr. Galton rightly attracts much attention, and those who have had their interest excited by Mr. Galton's curious portraits of thieves, ruffians, and consumptives, will be interested further by the portrait of American scientific men in NATURE, vol. xxxii. p. 176.

But in using this system as an instrument of discovery it must not be hastily assumed that by its means true averages are secured. At least, they cannot be averages in every respect Take, for example, the hair. The outer limit is determined by the greatest extent to which the hair has spread outwards on the plate in a number of sitters sufficient visibly to affect it—say three or four. But the inner limit is, in the same way, determined by the limit in the three or four in whom it stretched farthest in. Thus the result must be to give far more than the average amount of hair when the portrait is compounded from a great number of sitters.

As regards the nose, the eyes being the fixed starting-points, the root of the nose will be nearly a fixed point in the photograph; but the tip is limited by shading, and three or four short noses will be sufficient to determine where the tip is to be.

Again, the eyes being fixed points marked on the ground glass of the camera, and breadth between the eyes being different in different persons, it follows that those who have the eyes near together will be photographed on a larger scale than the rest. This enlargement will broaden the composite result. But the tip of the nose, like the tips of the really long noses, will be lost in the dark upper lips of others.

Proof that I am to an important extent correct in these remarks is to be found in your page of American portraits. They present a very remarkable non-American appearance about the nostrils, a vertical elongation accounted for by what I have pointed out. Also the ears are large and vague, the position of the ear relatively to the eye being variable; and there is a more than average breadth of face in three out of the four portraits.

I do not wish to detract from the value of these portraits, rightly understood, but assuredly they give prominence to certain types of face when these are mixed with others—namely, to broad faces with short noses, long lips, large ears, and a superabundance of hair—and it may be useful that attention be attracted to this.

It will be seen that composite portraiture is not suitable for anatomical objects whose generic characters are to be recorded in explicit statement. But for that and many other purposes, a trustworthy though more laborious and less elegant substitute may be found by determining the mean positions of a number of fixed points in figures accurately obtained. JOHN CLELAND

Ocular Images and After-Images

MR. NEWALL's experiment with the glowing match I have been in the habit of performing with my cigar or cigarette, and I have become familiar with the lurid ghost he describes, but the point that first interested me is one not mentioned in his letter, and has reference to the primary serpentine image. This I find to consist of a dark red head and a bright yellowish-red body—the light viewed at rest being of a mean tint, as if, owing to difference in rate of telegraphy, it underwent a process of analysis in its movement over the retina.

I have paid considerable attention to the dying phases of powerful retinal impressions, such as result from too bold a gaze at the sun or his vicar, the paraffin lamp, and am convinced that there is more to record than a mere fading away of a patch of colour. On careful scrutiny the patch is seen to be bordered with a series of coloured bands, which each in turn overspreads it; the order of succession being, unlike that of the primary image in the above experiment, towards the red.

I submit this for confirmation, being conscious that the region of these observations is so largely dominated by memory and imagination as to render it difficult at times to distinguish the psychical from the physiological. W. M. LAURIN

June 25

A Query as to Swallows

DURING a recent stay in Suffolk I found a belief prevalent there that swallows lay in necessary stores for their autumn migration by packing small flies under the feathers beneath the wings. My informant told me that he had shot a swallow once in order to ascertain whether this was actually the case; and that he had, as he expected, found many small flies beneath the down. Knowing how liable swallows are to parasitic invasions, I asked of what kind the flies were, and was told "Little gnats, and such like." Is this opinion to be found elsewhere, and is there any ground for it? E. H.

THE COMPOUND LOCOMOTIVE

VERY soon after the compound working of steam in marine and stationary engines became an accomplished fact, and the great saving of fuel thereby was apparent, the question of applying the compound principle to the locomotive attracted the attention of the locomotive engineers of this and other countries. At first it was received with very little favour, which is evident even at the present time, there being only two locomotive engineers in this country who are now either trying it experimentally or have it permanently in use on the lines under their control. This has been mostly caused by the idea that the additional gear necessary for the compound working with two or more cylinders would render the engines more liable to break down. Again it was thought, with very good reason, that such engines would have great difficulty at starting, for the reason that during the first revolution of the driving wheels all the power necessary to start the engine would have to be generated in the high-pressure cylinder. This difficulty was soon surmounted in engines fitted with only two cylinders working compound, by the addition of an arrangement by which the engine could be worked as an ordinary locomotive at the commencement, and when fairly started the compound arrangement could then be applied.

The usual arrangement adopted in the early trials of compound locomotives consisted of two outside cylinders of different sizes; the steam having passed through the

smaller cylinder was conducted to the larger one, after going through a sort of intermediate receiver in the smoke-box. The arrangement to work the engine non-compound consisted of a sort of slide valve controlled by the driver, by which means the direction of the steam from the boiler was so regulated that in one position the engine worked compound, and in the other in the ordinary way; this was called the compound valve, and was placed on the boiler with the necessary pipes leading to it, making the engine look very unsightly. In both positions the waste steam was exhausted in the usual way up the chimney.

Many combinations of the above arrangement have been tried both in this country and on the Continent. The earliest trials in England were made on the Eastern Counties Railway, now part of the Great Eastern system; on the Continent trials have been made extensively. In all cases the economy of fuel was at once apparent, but there was something in the arrangement which stopped its progress; this most probably being the general complication of the machinery, combined with a difficulty of management when at work.

In 1878 Mr. F. W. Webb, the able locomotive superintendent of the London and North-Western Railway, commenced to make experiments with an old locomotive converted to the compound principle; this engine had two cylinders of different sizes. The results of the trials were of such a promising nature, that he went thoroughly into the subject, and eventually brought out an entirely new arrangement with three cylinders, which he patented. This arrangement is a really good practical solution of the question of compounding locomotive engines, and visitors to the International Inventions Exhibition will there see the sort of way it has been accomplished. The compound locomotive, the *Marchioness of Stafford*, built at Crewe Works, is a really fine engine and a credit to the builders.

In attacking this problem Mr. Webb had several objects in view besides the saving of fuel by working the steam compound. His arrangement has enabled him to do away with two of the chief sources of anxiety pertaining to the management of locomotives.

In most non-compound locomotives designed to take heavy loads at a high speed the arrangement of coupling the driving and trailing wheels together by means of outside connecting-rods is a necessity; in order that all the available power of the engine may be exerted without slipping, the wheels are coupled, so that it may be transmitted by two pairs of wheels instead of one. These connecting-rods are a source of danger at high speeds, and when they break, which they sometimes do, the prospect of a serious accident is by no means distant. Again, in all engines having inside cylinders a two-throw cranked axle is required; this axle has to transmit the whole power of the engine; it has to withstand the constant vibration caused by points, crossings, and roughness of the road, besides the heavy straining caused by the powerful steam-brakes now in use. The breakage of this axle has been the cause of many serious accidents. In Mr. Webb's compound engine both of these sources of danger are done away with, and in place of the two-throw cranked axle we find a single-throw cranked axle, amply strong enough to be practically unbreakable, and giving a length of bearing otherwise impossible. The arrangement of the cylinders is as follows:—The engine has two outside high-pressure cylinders and one inside low-pressure cylinder. The high-pressure cylinders are attached to the frames about midway between the leading and central wheels, and are connected to two cranks at right angles on the trailing wheels. The low-pressure cylinder is placed between the frames at the leading end, and is connected to a single-throw crank on the axle of the middle pair of wheels. The valve motion is that designed by Mr. David Joy, which does away with all excentrics and rods, and considerably reducing the number of working parts per cylinder. This gear is singularly easy to adapt to the altered circumstances required in Mr. Webb's arrangement, and must have considerably helped him when designing the engine.

The working of the engine is as follows:—The steam is taken from the boiler through the regulator in the dome to the smoke-box, where it is divided, and taken by means of a pipe to each high-pressure cylinder; here it does a certain amount of work, and afterwards is returned in a parallel pipe into the smoke-box; each pipe is taken round the smoke-box and then enters the valve-chest of the low-pressure cylinder. Thus the steam is somewhat heated during its progress through the pipes in the smoke-box, the pipes themselves serving the purpose of an intermediate receiver. When the steam has completed its work in the low-pressure cylinder it is finally exhausted up the chimney.

The *Marchioness of Stafford* belongs to the class of most powerful compound locomotives yet built at Crewe, and is of course fitted with all Mr. Webb's latest improvements; the reversing gear is of special design, and only fitted to this class of engine. It is desirable in any compound engine to be able to vary the cut-off of the steam in the high-pressure cylinders without affecting the cut-off in the low-pressure, or the reverse; at the same time it is necessary to have the reversing gear of a locomotive all worked by one lever or wheel. Mr. Webb's arrangement will no doubt answer the purpose fully, the driver being able to vary the cut-off of the steam into the cylinders either individually or all at the same time according to circumstances.

These engines have now been at work some time, and are giving good results, both as regards fuel consumption and steadiness of running at high speeds. There are now thirty-four compound engines at work on the London and North-Western Railway, taking their turn in working some of the most important trains on the system, doing the work thoroughly well with a considerably less consumption of coal than that required by the ordinary locomotive.

Following Mr. Webb in solving the question of compounding locomotives we find Mr. T. W. Worsdell, the locomotive superintendent of the Great Eastern Railway, at work in the same direction, but evidently for a means of reducing the consumption of fuel, and not, as Mr. Webb has done, to try and make the locomotive at the same time less liable to break down at high speeds.

In Mr. Worsdell's design we have two inside cylinders of different sizes, with an arrangement to turn steam direct from the boiler into the low-pressure valve chest either when the high-pressure crank happens to be on one of the dead centres, or to augment the power of the engine in starting the train. This valve, compared with the old compound valve of the earlier experimental compound engines, is extremely simple, and is so arranged that when the driving wheels have made a complete revolution the engine will automatically commence to work compound. This engine is well designed and is a thoroughly good specimen of locomotive engineering, but we think Mr. Webb's engine is to be preferred, if only on the grounds that it does away with double-throw cranked axles and outside coupling rods. No doubt, as far as coal consumption goes, both engines will be very nearly equal, this being merely a question of proper proportions given to the cylinders and valves. Both gentlemen are to be congratulated on having broken through the bounds of locomotive practice and having succeeded in their different designs.

When we think of the millions of miles run each year by locomotives in this country alone, and that the compound working of the steam enables us to save three or four pounds of coal per mile run, the enormous saving is at once apparent, leading us to the conclusion that the compound locomotive has a great future.

THE GEOLOGICAL SURVEY OF BELGIUM

SINCE the publication of our note on this subject (NATURE, vol. xxxii. p. 154) letters have reached us representing both sides of the controversy; but into the controversy itself we do not propose to enter. The question whether this party or that is most orthodox and geologically accurate is not one that greatly concerns the world at large; but all who watch with interest the progress of national scientific undertakings cannot but feel regret that a geological survey which has already achieved such important results as that of Belgium should have been suspended. The Belgian Senate has followed in the wake of the Chamber of Representatives, and the Government is understood to be now engaged in the formation of a new Commission to deal with the reorganisation of the Survey. Meanwhile the field-work is suspended. Geologists everywhere will rejoice if by any means the Commission can succeed in producing better maps and memoirs; but those who are familiar with the publications of the Survey will not be very sanguine as to its success in this respect. They do not need better maps or memoirs, and can only regret that the further progress of the work should have been arrested for this year. The loss of a working season is itself a serious injury. The Belgian authorities would have acted more wisely had they kept the field-work going while they made any necessary investigations as to methods of procedure. We sincerely hope they may see their way to start the Survey again with as little delay as possible.

SYSTEM OF ORTHOGRAPHY FOR NATIVE NAMES OF PLACES

TAKING into consideration the present want of a system of geographical orthography, and the consequent confusion and variety that exist in the mode of spelling in English maps, the Council of the Royal Geographical Society have adopted the following rules for such geographical names as are not, in the countries to which they belong, written in the Roman character. These rules are identical with those adopted for the Admiralty charts, and will henceforth be used in all publications of the Society.

(1) No change will be made in the orthography of foreign names in countries which use Roman letters: thus Spanish, Portuguese, Dutch, &c., names will be spelt as by the respective nations.

(2) Neither will any change be made in the spelling of such names in languages which are not written in Roman character as have become by long usage familiar to English readers: thus Calcutta, Cutch, Celebes, Mecca, &c., will be retained in their present form.

(3) The true sound of the word as locally pronounced will be taken as the basis of the spelling.

(4) An approximation, however, to the sound is alone aimed at. A system which would attempt to represent the more delicate inflections of sound and accent would be so complicated as only to defeat itself. Those who desire a more accurate pronunciation of the written name must learn it on the spot by a study of local accent and peculiarities.

(5) The broad features of the system are that vowels are pronounced as in Italian and consonants as in English.

(6) One accent only is used—the acute—to denote the syllable on which stress is laid. This is very important, as the sounds of many names are entirely altered by the misplacement of this "stress."

(7) Every letter is pronounced. When two vowels come together each one is sounded, though the result, when spoken quickly, is sometimes scarcely to be distinguished from a single sound, as in *ai*, *au*, *ei*.

(8) Indian names are accepted as spelt in Hunter's Gazetteer.

The amplification of the rules is given below:—

Letters	Pronunciation and Remarks	Examples
a	*ah*, *a* as in *father*	Java, Banána
e	*eh*, *e* as in *benefit*	Tel-el-Kebír, Oléleh, Yezo, Medina, Levúka, Peru
i	English *e*; *i* as in *ravine*; the sound of *ee* in *beet*. Thus, not *Feejee*, but	Fiji, Hindi
o	*o* as in *mote*	Tokio
u	long *u* as in *flute*; the sound of *oo* in *boot*. Thus, not *Zooloo*, but	Zulu, Sumatra
	All vowels are shortened in sound by doubling the following consonant	Yarra, Tanna, Mecca, Jidda, Bonny
	Doubling of a vowel is only necessary where there is a distinct repetition of the single sound	Nuulúa, Oosima
ai	English *i* as in *ice*	Shanghai
au	*ow* as in *how*. Thus, not *Foochow*, but	Fuchau
ao	is slightly different from above	Macao
ei	is the sound of the two Italian vowels, but is frequently slurred over, when it is scarcely to be distinguished from *ey* in the English *they*	Beirút, Beilúl
b	English *b*	
c	is always soft, but is so nearly the sound of *s* that it should be seldom used	Celebes
	If *Celebes* were not already recognised it would be written *Selebes*	
ch	is always soft as in *church* ..	Chingchin
d	English *d* .	
f	English *f*. *ph* should not be used for the sound of *f*. Thus, not *Haiphong*, but	Haifong, Nafa
g	is always hard. (Soft *g* is given by *j*)	Galápagos
h	is always pronounced when inserted	
j	English *j*. *Dj* should never be put for this sound	Japan, Jinchuen
k	English *k*. It should always be put for the hard *c*. Thus, not *Corea*, but	Korea
kh	The Oriental guttural	Khan
gh	is another guttural, as in the Turkish	Dagh, Ghazi
l, m, n	As in English	
ng	has two separate sounds, the one hard as in the English word *finger*, the other as in *singer*. As these two sounds are rarely employed in the same locality, no attempt is made to distinguish between them	
p	As in English	
q	should never be employed: *qu* is given as *kw*	Kwangtung
r, s, t, v, w, x	As in English	
	.. ..	Sawákin
y	is always a consonant, as in *yard*, and therefore should never be used as a terminal, *i* or *e* being substituted. Thus, not *Mikindány*, but	Mikindáni
	not *Kwaly*, but	Kwale
z	English *z*	Zulu
	Accents should not generally be used, but where there is a very decided emphatic syllable or stress, which affects the sound of the word, it should be marked by an *acute* accent	Tongatábu, Galápagos, Paláwan, Saráwak

THE UNIVERSAL MERIDIAN[1]

II.

"IF, now, we examine the question of changes to be introduced into existing charts, these would, in accordance with our proposal, be imposed on the whole world; they might be greatly reduced, especially if people restricted themselves to what would be sufficient for a beginning, that is, by tracing on the existing plans only sufficient to allow us to make an immediate use of the international meridian. Later on, and in proportion as new plates were engraved, a more complete scale would be given; yet, in my opinion, it would always be of advantage to keep the two frameworks—the national and international—according to the example of what is done in several atlases.

"If, at the present time, it is necessary to facilitate external relations, it is also good for each people to maintain all the manifestations of its personal life and to respect the signs representing its traditions and its past.

"I do not insist on the details of the establishment of such a meridian. All we have to support before you is the principle of its acceptation.

"If this principle were admitted by the Congress, we are charged to inform you that you would there find a ground of agreement with France.

"Undoubtedly by reason of our long and glorious past, our great publications and our considerable hydrographic labours, a change of meridian would entail on us heavy and cruel sacrifices. Yet if one came to us, setting us an example of self-sacrifice, and thereby proving his sincere desire of the public weal, France has already given such proof of her love of progress that no doubt need be entertained of her concurrence in such an enterprise.

"But we should have to regret our inability to associate ourselves with a combination which, in order to safeguard the interests of one part of the contractors, sacrificed the higher scientific character of the institution, a character which in our opinion is indispensable if it would claim the right of imposing itself on all, and if it would secure to itself a definitive success."

Immediately after this discourse the general discussion was entered into, in which all the English and American delegates, and the Americans distinguished in science who had been invited, successively argued against the proposal of the French delegate. The latter had to reply successively to half a score of speeches embracing various phases of the question according to the various provinces of the speakers. It is, perhaps, allowable to say that notwithstanding the authority, talent and number of the distinguished speakers contending against the principle of the neutrality of the meridian, the principle withstood all those shocks without being shaken, and without suffering any scientific breach. The meridian proposed by France will remain always as representative of the impartial, scientific, and definitive solution of the question. We think it was a honour to our country to have defended this cause.

Before the vote, M. Cruls, the learned director of the Observatory of Rio de Janeiro, and delegate of Brazil, informed the French delegation that he had received instructions from the Emperor to vote with France. We were very glad at this concurrence of sentiment, and begged to be allowed to congratulate the august foreign associate of the Institute of France on his resolutions.

The following are the principal passages in the speech in which M. Cruls set forth the reasons of his vote:—

"Down to the present one point, and that of great importance, has been settled by the discussion—the necessity, namely, of fixing a single initial meridian. This point has, in fact, obtained the adhesion of all the delegates present at the Conference. This necessity recognised, it is proper to take a step farther, and to determine which shall be this meridian. An election of this kind forms at this moment the object of our debates, and a question on which we should have to pronounce our opinion.

"Our honourable colleague, Mr. Rutherfurd, delegate of the United States, has made a motion proposing the adoption of the meridian of Greenwich—a motion for the moment eliminated from our debates, its author having decided to withdraw it temporarily.

"The motion which was made at the last sitting, and formed the subject of numerous and interesting debates, is that formulated by our honourable colleague, M. Janssen, delegate of France, proposing that the meridian to be adopted should have a neutral character, and should not touch either of the great continents of Europe and America. This proposal has been strongly combated by the delegates of England and the United States, and valiantly defended by the delegate of France, and the debates thus arising on the question have furnished us with the opportunity of witnessing a scientific tournament of the highest interest. The speakers we have had the honour of hearing seem to me to have exhausted the whole series of arguments for and against; and at this stage I presume that the debates have enabled us, in full knowledge of the case in dispute, to form each his own opinion on the question on which we are called to vote.

"For my part I am anxious to have clearly defined the attitude which in my opinion Brazil is called upon to take in the midst of this assembly. This attitude is one of absolute neutrality so far, be it understood, as it is a question of choosing a national meridian—a question which may provoke among certain nations very legitimate personal rivalries.

"Now, till the day when the Conference assembled for the first time, I was in hopes that these debates, entered into under the influence of a generous aspiration, and with the single object of arriving at the establishment of a measure, the necessity of which is warmly proclaimed by manifold interests of diverse nature, might conduct us to a complete and definitive solution of the question. Unhappily, and to my great regret, I am compelled to add that the differences which have manifested themselves in the midst of the assembly do not allow this hope to be maintained.

"That which for my part I am not able to lose from view is the fact that it is indispensable that the solution of the question for which the Conference is assembled should be complete; or the end of this Conference would not be attained. Now, since the delegates of France have from the beginning of our debates manifested their opposition to the adoption of any meridian invested with a national character, an opposition which gave rise to the motion presented by M. Janssen, it follows that any measure voted by the Conference and tending to the adoption of a national meridian would, by the very fact of the abstention of France, be an incomplete measure, not corresponding with the object pursued by the Conference. I hasten to add, for fear of any erroneous interpretation being given to my words, that the same objection would apply, if, for example, the meridian of Paris were proposed, and any great maritime nation, such as England, the United States, or any other abstained from its adoption. In such a case, likewise, my line of conduct would be fully indicated.

"In short, I will say that the immense benefits which would accrue to the whole world from the adoption of a single prime meridian would be forthcoming in all their plenitude only in so far as the measure was unanimously accepted by the most important maritime nations. In every other case I am for my own part absolutely convinced that the measure would be in part inefficacious, its adoption not being general, and that everything would have to be done over again in a more or less distant future.

[1] Lecture by Dr. Janssen at the Paris Geographical Society. Continued from p. 151.

"Well, the debates at which we have assisted prove to me superabundantly that such will always be the unsatisfactory issue so long as the meridian of any great nation is proposed.

"In presence, then, of this difficulty, which on that supposition appears to me insuperable, the only solution which by its very nature will not excite burning questions of national jealousy is that of a meridian having a character of absolute neutrality. If the adoption of such a meridian were admitted in principle, I am certain that a discussion engaged in on the ground of pure science and directed according to the best conditions which such a ground is calculated to secure would soon lead to a practical solution.

"In such a discussion the arguments having any force should be, above all, drawn from science, the only source of truth alone able to enlighten us so as to guide us to a sound judgment and to a decision based solely on considerations of a purely scientific order.

"Such a practical solution seems to me, moreover, to be suggested by what our honourable colleague, M. Janssen, told us on this subject. The principle of the neutral meridian once adopted, the conditions it would require to fulfil and the determination of its site would remain to be discussed. Of two things—one, whether the meridian should be exclusively oceanic, and so by its very nature it would be neutral; or, second, whether it should cut some island, and in such a case there could be no obstacle, by means of an international diplomatic convention, in the way of rendering neutral the particle of ground on which it would be proper to establish an observatory, which in reality would be confined to a very small affair—of these two solutions both of which would satisfy the conditions requisite for the meridian, from the double point of view of its character of neutrality and the demands of science, I prefer for my part the second. I confine myself to intimating by these few words how it would be possible to arrive at a practical solution, since at this moment I have to occupy myself simply with the adoption of the principle of the neutral meridian.

"I conclude, then, by declaring that I shall vote in favour of the adoption of a meridian invested with the character of absolute neutrality; and in doing so I hope thus to contribute my part to the end that our resolutions may bear the impress of independence which they require in order to impose themselves spontaneously and naturally, generalise themselves in the future and rally from the beginning the adhesion of men of science, without distinction of nationality, who at this hour await our decisions."

I have to add that before the vote M. Galvan, the very distinguished representative of the Dominican Republic, who had studied at Paris under our most eminent masters, very cordially informed me that the attitude of France in this matter appeared to him to conform with that which the world was in the habit of seeing it take in all questions of general interest, and that it would give him such happiness once more to contribute in bringing a testimony of admiration to the nation—to the *puissante initiale de l'intellectuelle*, to use his own expression—by voting with France.

As to the vote, it was according to our expectations, seeing that, as I have said, almost all the delegates had received instructions to vote for the meridian of Greenwich.

The principle of the neutral meridian being rejected, we abstained from taking part in the discussion in the choice of the national meridian called to become international. As we already said, we did not come to Washington to sustain a candidature, but a principle.

Before the vote, M. Valera, delegate of Spain, announced that he was charged by his Government to say that, in voting for Greenwich, Spain expressed the hope that England and the United States would accept the French system of weights and measures. This declaration led Gen. Strachey to say that he was authorised to announce to the Conference that England had asked to join the Metric Convention.

We cannot pass over in silence the part taken in this discussion by the eminent Foreign Associate of the Institute of France, Sir William Thomson, who was then in America, and had very naturally been invited to our sittings. Sir William Thomson expressed his desire of an accord in regard to the meridian and the metrical system. The following are among the few words he spoke on this subject:—

"I cherish the sincerest and most ardent desire that the delegates of France and those of the other nations who by this vote supported the previous resolution, will be able to adopt the resolution now before the Conference. It appears to me that we have here to do with a sacrifice, and I am convinced that the honourable delegate of France who last spoke, M. Lefaivre, will clearly apprehend that there is no question of asking a sacrifice of France which she is not disposed to make.

"In the admirable speech delivered by M. Janssen before this Conference (a speech I had not the pleasure and satisfaction of listening to, but which I read with the greatest interest) he declared that France was willing to make a much greater sacrifice than that now in question. The amount of sacrifice involved in changing certain usages is always more or less considerable, in view of the fact that it is impossible to say that such an innovation can be effected without derangement. It may, however, be asserted that the sacrifice France is prepared to make would be much more considerable than that ensuing from the adoption of the resolution now before us.

"If the resolution relative to a neutral meridian had been adopted, all nations would have been called on to make the sacrifice involved in a change of meridian not yet determined, and the relations of which to the meridians now in use could not have been so easy as would be those of the meridian of Greenwich with the meridians at present employed.

"I am of opinion that if the delegates of France could see their way to the adoption of this resolution, they would have no cause to regret it.

"I highly approve of what has been said in regard to a common metrical system. My opinion on this subject is firmly established, and I shall by no means express it if the President thinks it would be inexpedient to enter on this subject; but it seems to me that England makes a sacrifice in abstaining from adopting the metrical system. The question cannot, however, be presented under this form. We have not to consider here whether England would gain or lose by adopting the metrical system.

"Such is not the way of looking at the question, considering that the adoption of the metrical system by England is a question restricted to her own convenience, to her own usages, and that whether she adopted it or not, her decision could not in any way affect other nations. It could result neither in advantage nor disadvantage of other countries."

When the meridian of Greenwich was adopted, the Assembly considered that it devolved on it to define the principle according to which the longitudes should be numbered. Should they be counted in one single direction in accordance with the almost unanimous opinion of the distinguished members of the Conference of Rome, or should they continue to be counted in the two opposite directions, as far as the anti-meridian? The latter method was adopted.

The method of counting longitudes east and west, starting from a central meridian—the method actually in general use—was evidently introduced and actuated by the use of national meridians. But when, instead of looking merely at one country in particular, the entire earth is contemplated, and it is desired to bring the general system of longitude into relation with a universal

time, it is difficult to understand how in counting the longitudes, one should stop in the middle of the way, while in counting the time one goes the whole round of the day, reckoning the hours from 0 to 24, according to the decision of the Congress.

We are unwilling to believe that the advantage of not having to make any change in use and wont, not even to the extent of a few figures on English maps, was the ground of this decision on the part of the majority.

This majority, for the rest, consisted in a preponderance of but three votes, and among the opposite voters or abstentionists we observe all the great Powers, with the exception of Russia.

The question of a meridian being completely settled, the assembly had to address itself to the second part of its programme—that relating to universal time.

The commercial and maritime relations so developed at the present day by the progress of the marine and telegraphy render the inconveniences attending a diversity of origins in horary measures more sensible every day. It has, therefore, come to be desirable to establish a division of time having the same point of departure for the whole world. To attain this object the local time of a determined point is taken, and by a convention is made the universal time. In this system the influence of longitude is entirely eliminated. The same instant receives the same name all over the earth, and the acts of international life are dated in as close relation to each other in point of time as though they were acts transpiring all within the same town. As to the point to be chosen for giving the universal time, it is plain that it ought to be the same as that adopted for giving the departure of longitudes. The two systems cannot be separated.

As a matter of course, this universal time cannot claim to take the place of local time, nor of so-called national time. The local time, which is the expression for each place, at least very approximately, of the course of natural phenomena, the eternal regulators of the acts of life, can never be displaced. In the case of certain arrangements, such as that of railways, for example, is it found highly convenient to extend the use of the local time of the capital to the whole country, when this latter has not a too considerable range of longitude. Such is the case in France.

The Congress adopted in principle the establishment of a universal time defined in the manner I have just described. But, separating itself again on this point from the Congress of Rome, it assigned as the origin of the universal day the midnight of Greenwich, which, according to the proposals of the Washington Congress, should become the beginning of the day for international transactions all over the world.

The divergence of resolutions adopted at Rome and Washington in reference to the origin of the international day brings clearly into view the inconveniences of the vexatious disagreement still actually existing between the origin of the astronomical day placed at midday, and that of the civil day placed at the preceding midnight. This inconvenience grows greater and greater in proportion as the ephemerides and astronomical studies extend. We therefore eagerly associated ourselves to the resolution expressed by the Congress relative to the unification of the two systems, by making the astronomical day commence at midnight, like the civil day.

Astronomers will, we hope, understand that, being a far less numerous body, and much more conversant with these matters, it is on them that it devolves to make a slight sacrifice, so as to allow a progress very desirable at the present day to be effected.

After the discussion of these various questions, the labours of the Congress approached their term; it was then that the French delegation made the proposal it had been charged to present—a proposal having reference to an important extension of the decimal system.

The Congress of Washington, by its importance and by its object, which aimed definitively at the continuation of that great French work of unification and of progress inaugurated at the end of the last century, offered an altogether appropriate opportunity to ask for the world a new extension of those applications of the decimal system which constituted the whole merit and the whole success of our reform of weights and measures.

This extension had relation to the measurement of angles and of time.

At the date of the establishment of the metrical system the decimal division was, as is known, extended to the measure of angles and time. Numerous instruments were even constructed according to the new system. As far as time is concerned, the reform, introduced too drastically and without sufficient discretion, it may be said, clashed with too inveterate usages, and was rapidly abandoned; but in regard to the measure of angles, where the decimal division presents so many advantages, the reform held its ground much better, and has maintained itself in certain practices to this day. Thus, for example, the division of the circumference into 400 degrees was adopted from the beginning by Laplace, and it is currently employed in celestial mechanics. For the measurement of the arc of the meridian, whence the metre was derived, Delambre and Mechain availed themselves of repeating circles divided into 400°. Finally, in our days, Col. Perrier, Chief of the Geographical Service at our Ministry of War, makes use of instruments with decimal division, and at this moment calculates even logarithmic tables with eight decimals appropriated to this mode of division.

It is above all, however, when it is required to execute long calculations on angular measures that the decimal division presents immense advantages. On this point nothing but unanimity may now be said to reign among learned men.

The Conference of Rome, which assembled so many astronomers, geodesists, and eminent topographers—that is, just the men of most weight and having the greatest interest in the question—issued on this subject a resolution the high authority of which it is impossible to disregard.

It is now, then, evident that the decimal system, which has already rendered so many services in the measurements of length, of volumes, and of weights, is called upon to render analogous services in the domain of angular magnitudes and of time.

I am aware that this question of the decimal division has to contend with legitimate apprehensions, principally in reference to the measure of time. People are afraid of doing violence to secular customs and overturning consecrated usages. On this aspect of the business I think we ought to be fully assured. The lessons of the past will be put to profit. It will be understood how it was for having endeavoured to push a reform beyond the due domain of science, and for having done violence to the habits of daily life, that disaster was experienced during the epoch of the Revolution. It is proper to resume the question, but it is proper to resume it with an appreciation of the limits which good sense and experience will always indicate to wise and experienced men.

I think the character of the reform would be sufficiently indicated by saying that the question is principally to make a new effort towards the application of the decimal system in the scientific world.

We met at first with a sufficiently warm opposition. The President was of opinion that the proposal should not be offered for discussion, but I have to acknowledge that he finally yielded very courteously, "out of deference," he said, "to the delegates of France, and because we are happy to do them honour in all things."

The majority decided that the proposal should be discussed. The French delegate then spoke, and the meeting passed to the definitive vote. The success was

then complete, for the proposal was adopted by twenty-one votes, without one dissentient voice.

Such is the work of the Congress.

This work is considerable. Its importance, however, is derived much more from the principles enunciated by the Congress than from the solutions it adopted.

The establishment of a single meridian and of a universal day, the unification of the astronomical and civil days, the extension of the decimal system,—these are reforms which the progress of science and of international relations rendered opportune and desirable.

In the application, however, of the principles, the Congress has been less successful.

In the choice of a primary meridian it allowed itself to be too much carried away by the practical and immediate advantages of a meridian already in very extended use, and disregarded the conditions which would have assured to its work a universal and definitive adoption.

In regard to ourselves we have in this question adhered to the part prescribed to us by our past, our traditions, and the very character of our national genius. Our proposal was precisely that which we should have adopted ourselves if we had had to take the initiation of this reform. The nation which created the metrical system could propose none other than it did. If our purely scientific and disinterested opinion did not unite the majority around it, the reverse was not for France, but for science. But science is the sovereign of modern times and one cannot now detach himself from it with impunity. It is vain to say that the meridian of Greenwich is *de facto* the universal meridian, that it reigns to-day over almost all the navies of the globe, and that its adoption only consecrates a fact which has already established itself and transforms into law the institutions of fact.

I reply that that is all true. I even add, if it is desired, that such is only what is merited by the great labours of the English marine—labours which we, the initiators of hydrography, more than any others appreciate at their true value. But however considerable may be these labours and however great the numbers of those availing themselves of them, yet with the experience of the past and in the name of history I say that these merits will not be able to prevent the inevitable consequences resulting from the personal character of this meridian. And in point of fact, has not France—she, too—had a great geographical career? The meridian of the Island of Ferro, which soon, in the hands of Gillaume Delisle and of our great geographers of the eighteenth century, became French—did it not bear sway in cartography for more than two centuries, and that with an authority not even equalled to-day by that on the other side of the Channel?

And yet the meridian of the Isle of Ferro, after that brilliant career, is to-day more and more abandoned, and the fair attempt of the seventeenth century finds itself entirely compromised!

What is the cause, then, which has led to this vexatious result? Apparently a mere trifle. It is because, as we have already said, instead of leaving the meridian of the Isle of Ferro in conformity with its first intention, instead of maintaining it in the purely scientific character which it received from the hands of Richelieu, that great spirit who so well understood that an institution of a universal order must bear no personal investiture, this character was imprudently changed by bringing the position of this meridian into relation with that of Paris, in place of bringing the position of this capital, like any other point, into relation with it.

That is the mistake which compromised the fortune of this reform so firmly and so judiciously established by its illustrious author. Now, this mistake, is it not committed to-day by once more taking a national meridian and making it the universal point of departure for longitudes? Is one not then justified in foreseeing that the same causes would produce the same effects, with this difference, nevertheless, that in the advanced state of civilisation prevailing to-day among the nations, a particular supremacy, of whatever nature, would be much more promptly abandoned than it was two centuries ago?

It is, accordingly, much to be feared that the establishment of the new meridian, if it even succeed in getting established, would again be but an attempt without a future.

France who finds in the history even of her own past the double lesson of the progressive abandonment of her national meridian and of the ever growing appreciation of the scientific and impersonal system of weights and measures, ought to make known to the Congress a counsel dictated by her own experience.

Does this attitude, however, sufficiently absolve us? Have we discharged towards the world and towards ourselves the debt due by a generous and enlightened nation which has always been delighted to take the initiative in tasks conducive to the general well-being? I do not think so; and, were it allowed me to express a wish, it would be that we should on this occasion again join example to precept. I should like that the France of the nineteenth century, considering herself the heir of the France of the seventeenth, would, with the benefit of the experience she has in that interval acquired, resume the fair attempt of Richelieu and herself establish the neutral meridian.

This institution, well conceived and planted on exclusively scientific bases, would gradually rally to it the adhesion of all. England herself, who, if possessing a lively national sentiment, has likewise an appreciation of what is just and great, would end by attaching herself to it, and then would this reform so long desired, always attempted in vain, and again quite recently compromised, be finally secured to the world and to science.

Be that as it may, and outside the question of the meridian, which is not yet settled, let us not forget that the accession of England to the Metrical Convention and the resolution for the extension of the decimal system are results demonstrating that our presence at Washington was not useless either to science or to progress.

THE VOYAGE OF THE "CHALLENGER"[1]

I.

NINE years have slipped away since the memorable expedition of the *Challenger* came to a close. During this interval from various published accounts of the voyage, the route around the world, the places called at, the life on board, the impressions, social or biological, left on the minds of the voyagers—are all now more or less familiar to us. There have likewise appeared numerous detailed quarto reports from different experts, into whose hands the great natural history collections amassed during the expedition were placed for description. We know precisely the additions made by the naturalists of the *Challenger* and their collaborateurs to our knowledge of the foraminifers, corals, medusæ, ostracods, brachiopods, echinoids, shore fishes, birds, and many other groups, and from the list of memoirs yet to come we can see how ample a store of detail is still to be produced. We know also how vast an amount of additional information has been gathered by the expedition regarding the physics and chemistry of the ocean. But as yet there has been no condensed official record of it all. The general public, and even the man of science, cannot be expected to master the series of special reports; life is too short for this, even if the power of comprehension were adequate. Admirable and exhaustive as the reports are, and indispensable for experts in the various branches of which they treat, each of these must necessarily appeal to a comparatively small

[1] "Report on the Scientific Results of the Voyage of H.M.S. *Challenger* during the years 1873-76." Prepared under the direction of the late Sir C. Wyville Thomson, and now of John Murray. "Narrative," vol. I., 1885

circle of readers. What has been needed is such an official summary of the whole work of the expedition as will convey to the general public a sufficiently clear and detailed account of the whole results of the voyage of the *Challenger*, and will enable the man of science to realise what has been done in other departments than his own special domain.

Such a summary has now been prepared and published as the "Narrative of the Cruise." It is called a volume, though in reality it consists of two stout quartos, comprising altogether upwards of 1100 pages. The first thought that will naturally occur to any intelligent person who takes an interest in these subjects, and who hears that at last the official narrative of the *Challenger* expedition is issued, will be that this at least is a part of the publications that he would like to possess, or at least would expect to find readily accessible as an authoritative and convenient record of what the expedition has done. His zeal

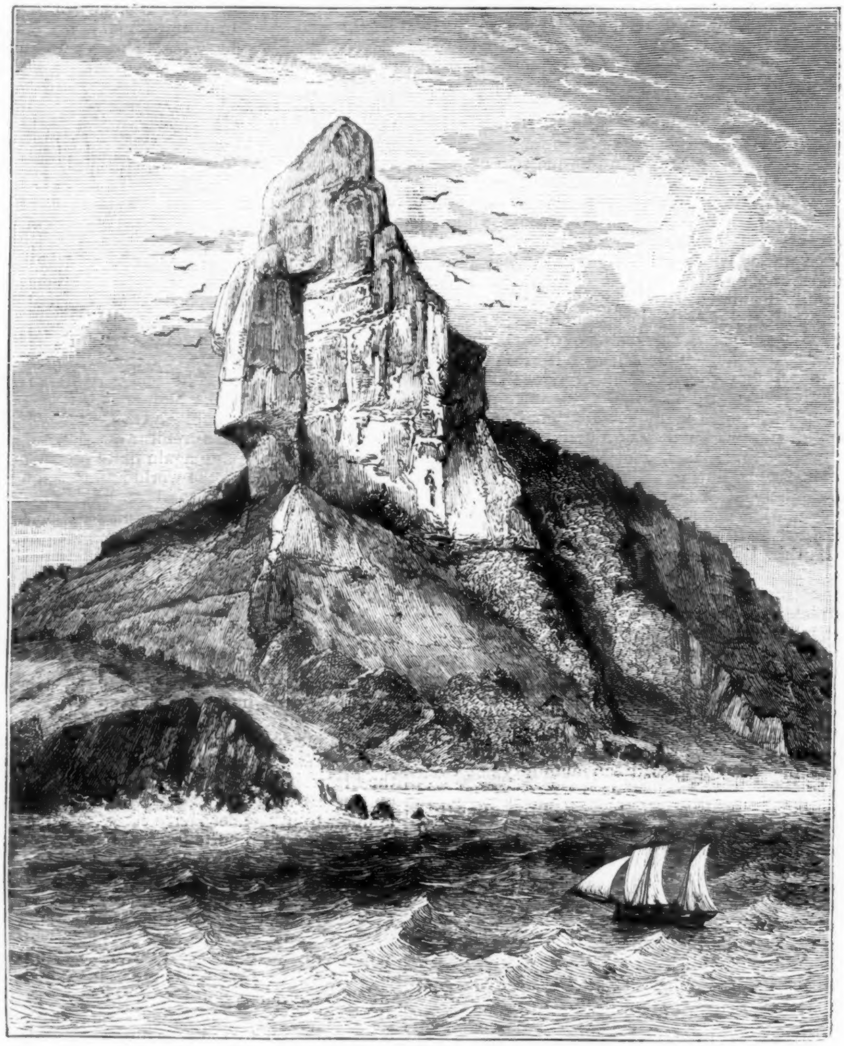

FIG. 1.—The Peak of Fernando Noronha, sketched from the Deck of H.M.S. *Challenger*, September 3, 1873.

for the acquisition of knowledge, however, may not improbably be damped when he learns that the book will cost him *6l.* 16*s.* 6*d.* Why such a prohibitory price should have been affixed to this work is one of those mysteries of Government publication which it is hopeless to understand or explain. There can be no question that this Narrative volume is the one of the whole series most likely to sell. There are, no doubt, hundreds of institutions and private individuals that would gladly purchase it if the cost were within their means, but to whom the acquisition of the whole series of Reports, or even a small proportion of them, is impossible. The official rule has been, we believe, to print off only 750 copies of each Report, to charge the whole cost of production upon that number, and then to destroy the copper plates and lithographic stones, so that on the supposition that the whole edition is sold, no loss

from its publication will be incurred by the national exchequer. This may or may not be a judicious rule for the reports of specialists for which no great sale can be expected; but surely it is not a wise one in the case of the Narrative volume, for which a much wider circulation may confidently be expected. It is understood that the type and plates of this volume are kept up, so that if the present edition is sold off another may be printed. But as the cost of production has been charged upon the first edition, every copy subsequently produced will cost nothing but the mere paper, printing, and binding. Government cannot, of course, wish to make profit out of the book as a commercial speculation. Would it not have been more in accordance with common sense and trade economy to have issued a much larger edition at first, and to have spread the cost of production over the whole of it? Had the book been sold at half its present price its sale would probably have been more than doubled. That,

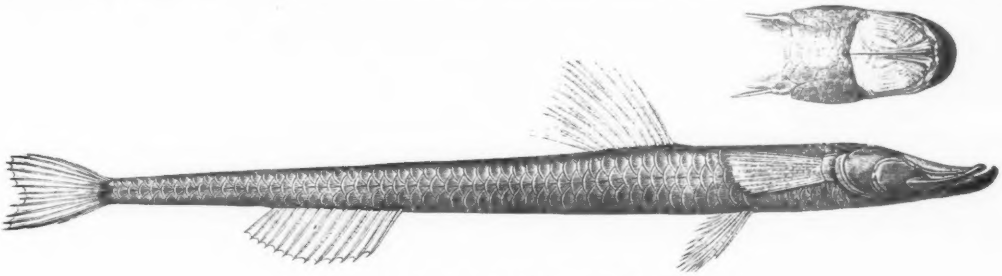

FIG. 2.—*Ipnops Murrayi*, Günth., 1600 to 1900 fathoms.

even as it is, the whole edition will be sold we confidently believe. But that will be no justification whatever for making the price so high. After so large a sum of money has been spent upon the expedition first and last, it seems perfectly childish to publish the results in such a form that even the most generally useful and intelligible part of them are out of the reach of most of those who really feel an interest in them.

There is another question which my Lords of the Treasury will have to face in regard to this Narrative volume. Many requests have been made to that pachydermatous body for gifts of different reports; many more would no doubt have been made but for the known determination on the part of the authorities to refuse them. Now, it is tolerably certain that public libraries all over the country will ask for at least copies of the "Narrative of the Cruise," and the whole of the first edition would probably barely suffice to supply their demand. That their requests will be again

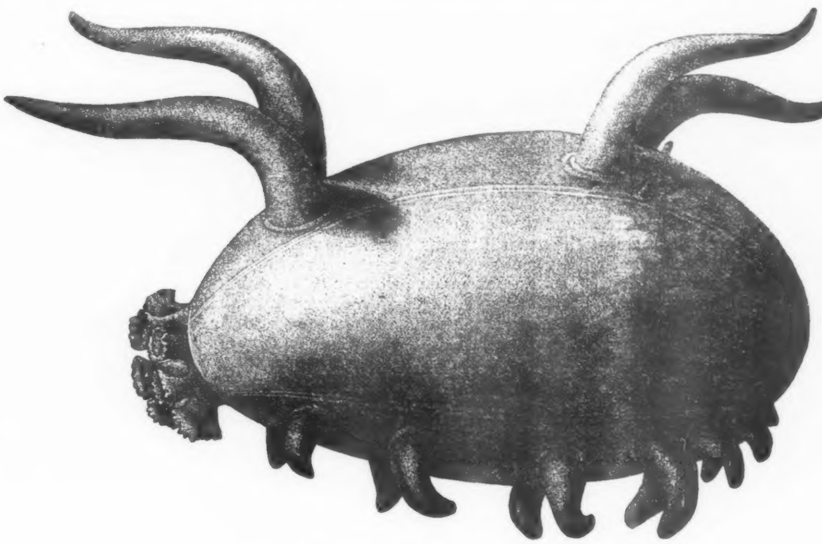

FIG. 3.—*Scotoplanes globosa*, Théel.

refused goes without saying. But it will be noteworthy if these public institutions are content with the refusal. The country has a right to insist that the results of an expedition on which so much public money has been spent shall be made as widely accessible as possible, and will no doubt brush roughly aside the stereotyped official objections. A more flagrant case of the stupidity into which a blind adhesion to red-tape rule may lead a Department that no doubt means well could hardly be found than this Narrative volume and its price of 6*l*. 16*s*. 6*d*.

With this preliminary protest we gladly pass on to notice the book itself. First of all, like the previously published Reports, the "Narrative" is admirably got up. The paper, print, illustrations, and binding are so vastly superior to ordinary Stationary Office productions that we wonder more than ever how the Treasury officials were

ever prevailed upon to sanction such expenditure, even though with the prospect of charging a high price. The book is in two parts, each of which forms a thick, heavy quarto of more than 500 pages. It contains 14 chromo-lithographic plates, giving illustrations of deep-sea deposits, Antarctic icebergs, and various aborigines and their handiwork; 35 photographic plates, among which the glaciated pavement at Halifax, the lava-cascade at Kilauea, and some of the representations of growing vegetation are particularly good; 43 charts of the route of the voyage and of stations visited, including a large and valuable physical chart of the world on which all the newest information as to ocean depths is given, together with the track of the *Challenger* and the nature of the bottom observed in the different soundings; 22 diagrams showing the vertical distribution of temperature in the ocean, and embodying in a graphic and intelligible form a vast amount of detail regarding this fascinating subject; 340 woodcuts, including many illustrations of the more novel or interesting natural history "finds" of the voyage, and some of them remarkable for the exquisite beauty and fidelity with which they have been executed; and, lastly, which will surprise the reader accustomed only to the prosaic solidity of Government publications, there are tail-pieces to the several chapters—mermaids filling the tow-net for the naturalists above, scenes from the life of the cruise on deck and on shore, and little bits of fancy that remind one sometimes of Edward Forbes.

The general scope of this "narrative" was sketched out by Sir Wyville Thomson, and in his preface to the first volume of the "Zoological Reports" he referred to it as actually in progress. He died, however, before he had made any progress with it, the world losing in him the enthusiastic and kindly spirit that planned the whole expedition, saw it successfully completed, and organized the systematic working out of its collections. Since his lamented death the work has been vigorously prosecuted by his successor in the editorial supervision of the Reports, Mr. John Murray, who, in conjunction with Staff Commander Tizard, Professor Moseley, and Mr. J. Y. Buchanan, and with the co-operation of the various specialists employed, has compiled this voluminous "Narrative of the Cruise."

The general plan of the work may be briefly stated. The leading idea of the writers has been to give a chronological account of the voyage from beginning to end, recording at each station any remarkable observation there made, inserting here and there, where they could be most appropriately given, abstracts of the general results arrived at up to the present time by the various experts to whom different portions of the vast collections made during the cruise have been entrusted, and describing fully the various equipments of the *Challenger* for the scientific work for which the expedition was designed.

Some of these features of the book have, of course, already become more or less familiar from the publications of Sir Wyville Thomson himself, and of Professor Moseley, Lord George Campbell, Mr. Wild, and others. But they have never been presented so fully nor illustrated so amply. Unfortunately all the scientific work connected with the expedition is not yet completed, so that it was not possible to give in the "Narrative" a summary of the whole results achieved. But as far as the work had advanced up to the time of its publication, the volume now issued contains a digest of it, prepared by the various specialists by whom it has been accomplished. When the whole *Challenger* results have been published, we hope that in a future edition of the "Narrative," a conspectus of the entire work of the expedition may be completely given.

The introductory chapter presents an outline of the history of research in the ocean. This is followed by a detailed account of the fittings of H.M.S. *Challenger*, which will be useful as a record of the state of deep-sea investigation in 1872. The proper narrative then begins with the departure from Portsmouth, the various trials of the apparatus and training of the crew in the kind of work which was to be prosecuted during the cruise, and a full description of the instruments employed and the methods of observation with them. This, though to most readers rather a dry subject, is here treated with a fulness not elsewhere to be found. The account of the thermometrical observation and of Professor Tait's subsequent researches, with the actual instruments employed, is a valuable part of the book. Listening to these detailed descriptions of what they were trying to do and how they attempted to do it, we are hardly aware that we have been carried through more than a hundred closely printed pages, and from the shores of Old England to the Peak of Teneriffe. But the real work of the expedition was now to begin with the running of a section across the North Atlantic. A good deal of information from previous observation was already in existence regarding the depths and form of the bottom of this ocean. But no such series of soundings had ever been made across it as was now to be carried out by the *Challenger*. Twenty-four soundings, fifteen dredgings, two trawlings, and thirteen serial temperature soundings, were taken between Teneriffe and the West Indies. A brief description of the more interesting features of these researches is given, and then, as we are carried onward to Bermuda and as the various treasures of the deep are brought before us, some species of brachiopods hauled up from the bottom afford an opportunity of hearing Mr. Thomas Davidson discourse regarding his examination of the whole of the brachiopoda collected during the cruise. At Bermuda we hear again of the wonderful Æolian rocks, which from the early descriptions of Captain Nelson down to those of Sir Wyville Thomson have attracted the notice of geologists. Running up to Halifax, Nova Scotia, we catch a glimpse of the wonderfully glaciated rocks of that region, and on the return voyage to Bermuda we watch the officers of the Expedition gauging the temperature and depth of the Gulf Stream, and bringing up an Arctic fauna from depths of 1250 to 1700 fathoms. Among the novelties taken are a curious ascidian, which gives occasion for a short discourse from Professor Herdman regarding the tunicata discovered and brought home by the *Challenger*.

In this pleasant and instructive way we are led on from station to station, noting clearly and vividly what the ship passed through and what its scientific staff were engaged in. From Bermuda we are once more borne across the Atlantic and take part in another series of soundings and dredgings to check or confirm those obtained in the westward passage. Among the more interesting observations in this second traverse were those on the occurrence of various abysmal brittle stars, some from a depth of 2850 fathoms, and Mr. Theodore Lyman, into whose hands the whole of the ophiurans collected during the cruise were placed, gives us a *résumé* of his study of them. After some time spent in observations among the Azores and Cape Verde Islands, we are carried southwards to St. Paul's Rocks, of which an interesting account was, long ago, given by Darwin, and to which attention has recently been called by the Abbé Rénard, whose investigation of the microscopic structure of the rock has already appeared in the Reports of the *Challenger* expedition. We catch a tantalising glimpse of Fernando Noronha, regarding which little new information can be obtained, since the Governor refuses permission to make collections. So, casting a wistful look at its colossal peak (Fig. 1) we are transported to the coast of Brazil, and thence back again into the centre of the South Atlantic where the lonely rocks of Tristan da Cunha rise above the waves. This section of the voyage is full of interest. The naturalists are evidently getting more practised in their duties, the crew more expert in the labours of sounding, trawling, and dredging, and the hauls are more generally successful than in the earlier weeks of the cruise. The dredgings

and trawlings along the American coast are specially important, bringing to light many new forms belonging to nearly all the invertebrate groups, and the first specimens of a new genus of nearly blind fish (*Bathypterois*). A *résumé* of all that has been added to our knowledge of the radiolaria is here inserted, with some excellent woodcuts which bring the structures of these beautiful organisms clearly before the eyes. On the way to Tristan da Cunha another new genus of fish (*Ipnops*, Fig. 2) is brought up having a quite unique structure of eye which appears to be designed for detecting the presence of very small quantities of light at great depths, at the expense of all apparatus for forming an image. From Tristan da Cunha, of which an interesting description is given with good illustrations, the section of the South Atlantic is continued to the Cape of Good Hope. The tow-nets did not yield such a rich assemblage of life as in the more tropical parts of the ocean, but the account of this section is enlivened by a summary from Dr. Hjalmar Théel of Upsala, giving the results of his examination of the holothurioidea collected during the whole cruise. One of the curious new forms described by him is shown in Fig. 3. From the Cape of Good Hope the *Challenger* strikes away south-eastward into the Antarctic regions, but a notice of the further progress of the cruise must be reserved till next week.

(*To be continued.*)

NOTES

THE death is announced at Lund, Sweden, of the distinguished physicist, Prof. A. W. Eklund, at the age of ninety years.

WE learn from *Science* that at the meeting of the American Association at Ann Arbor on August 26, the University will furnish electricity, either from a dynamo, from a storage-battery, or from primary batteries, as may be needed by members reading papers on electrical subjects. An evening reception on a day not specified will be given the association at the court-house, together with a lawn-party on the University grounds at the close of one of the regular sessions. The Excursions Committee has nearly completed arrangements for a trip, free of all expense, to the Saginaw Valley, including a steamboat run down the river, and view of the cities of Saginaw, East Saginaw, Bay City, and West Bay City, and the enormous industries in salt and lumber manufacture which have given the Saginaw Valley a world-wide celebrity. This valley produces annually a billion feet of lumber, and the excursionists will see half a billion piled on the docks. In conjunction with these vast lumber operations will be seen the production of salt on a scale unequalled in the world, and employing the various improved processes. The Committee has also arranged for excursions to Detroit and Mackinack Island, with side trips to Salt Marie, Pectoskey, and Marquette. Those wishing to make any special inquiries or arrangements should address Prof. J. W. Langley, local secretary, Ann Arbor.

A BARONETCY has been conferred upon Mr. Isaac Lowthian Bell.

THE Indian Government has sent a geological surveyor to report on the scientific aspects of the Cashmere earthquake of May 13. Further shocks are reported with renewed violence on June 24 and 25. A correspondent of a Calcutta journal, writing on the second day after the first great shock, says that the force of the earthquake appeared to have concentrated itself at certain spots, nd there to have spent itself. These spots look as though a large amount of gaseous matter under the earth had, with the strength of dynamite, been struggling for an outlet, and had torn and lacerated the ground at the point where it found an exit. Thus villages are seen with the huts all destroyed, the earth adjacent being cracked and split, and the air putrescent from the bodies of cattle buried under the houses, while not twenty yards distant a sloping, wooded hill seems untouched. In other places the side of a vertically-scarped hill has been sliced off as if by the guillotine, the earth so severed lying at the base. Some hill-sides are only partially disconnected, and a deep incision remains. Other hills present the appearance of an ordinary landslip. Near the village of Lalledourah three enormous chasms have been formed, one about three-quarters of a mile broad and 20 feet deep. Not far distant a tract of land 800 yards square has subsided, forming a trench 100 yards long, 50 feet deep, and 30 feet wide. The latest returns regarding the damage give the loss of life at 3081 persons, besides 25,000 sheep and goats and 8000 cattle. The number of dwellings destroyed is estimated at 75,000.

A VIOLENT shock of earthquake was felt at Douai, Dognies, and Flers-en-Escrebieux on Wednesday, June 22. The phenomenon was preceded by a rumbling sound, which is described as having resembled the distant report of a cannon. It occurred at ten minutes past four in the morning, when most of the inhabitants were still in bed. Many of them were awoke by the shock, and were so alarmed that they rushed in their night-clothes out of their houses into the streets and roads. The oscillation of the ground stopped a great many of the clocks. No very serious damage was done.

THE New York correspondent of the *Standard* telegraphs that the receipts from Prof. Tyndall's lectures in the States in the year 1872 now amount to a fund of 32,400 dollars. The Professor desired that the money should be devoted to the sustentation of science fellowships; but a difficulty arose in satisfying the conditions of the deed of gift, and meanwhile the money has accumulated. Acting, however, upon a suggestion from the trustees of the fund, Prof. Tyndall has now directed that the money shall be equally divided between the Universities of Columbia, Harvard, and Pennsylvania.

THE ninth anniversary meeting of the Sanitary Institute of Great Britain will be held, by the kind permission of the Board of Managers of the Royal Institution, in their Lecture Theatre, Albemarle Street, on Thursday, July 9, at 3 p.m. The chair will be taken by Sir John Lubbock, Bart., M.P., D.C.L., F.R.S. An address will be delivered by Prof. W. H. Corfield, M.A., M.D., entitled "The Water Supply of Ancient Roman Cities," and the medals and certificates awarded to the successful exhibitors at the Exhibition held at Dublin, in 1884, will be presented.

THE Organising Committee of the General Meeting of the Italian Meteorological Society, which meets in Florence from September 8 to 14, was held on May 15, under the Presidency of Prince Corsini, who was elected President of the General Meeting, the Vice-Presidents being Profs. Cecchi and Neucci, and the Secretary, Sig. Giovannetti; the Committee then divided into two Sections, one for scientific purposes, the other for practical and executive purposes.

THE Norwegian Government have contributed a sum of about 200*l*. for the prosecution of various researches during the summer, amongst which may be mentioned the zoological studies of Prof. R. Collett in East Finmarken; the entomological, malacological, and hydrographical studies of Dr. Schneider in the province of Tromsö; the researches of Dr. Johannsen on the appearance of struma in the vicinity of the lake Mjösen; and the algological studies of Herr Foslie on the south coast of Norway. A sum of 350*l*. has also been granted to the Society of Science at Christiania, as well as the usual annual grant to Dr. Sophus Tromholt for the prosecution of his studies of the aurora borealis.

ACCORDING to the Paris Correspondent of the *Times*, the Academy of Sciences, whose turn it is this year to award the Institute's biennial prize of 20,000f., has pronounced in favour of Dr. Brown Séquard.

ACCORDING to the Swedish papers, on the evening of June 19 a crane was shot at Orkened, in Scania, which had a parchment card tied to its neck with the following lines written in ink :—

I come from the burning sand
From Sudan, the murderers' land,
Where they told the lie,
That Gordon would die.

The bird had previously been wounded in the wing, and was very exhausted.

THE Japanese have at last, after much hesitation, promulgated a patent law. As in America, with respect to copyright, it was argued that with no patent protection the Japanese got the benefit of the inventions of the whole world. The new law appears, like many other recent Japanese laws, to be compiled from similar laws of other countries—a clause from England here, from France there, from Germany in another place, as seemed advisable in the circumstances. The term of protection is fifteen years; "articles that tend to disturb social tranquillity, or demoralise customs and fashions, or are injurious to health," and medicines cannot be patented; the inventions must have been publicly applied within two years, and patents will become void when the patented inventions have been imported from abroad and sold—an illiberal provision which prevents the patenting of foreign inventions in Japan unless the inventor also manufactures them in the country, and which therefore renders the new law practically useless to any but the Japanese inventor. The fees are low, amounting to about three pounds sterling for fifteen years' protection, the one payment down being sufficient, while there are no annuities or annual payments for keeping the protection in force, as in many European countries. The punishments for breaches of the regulations are sufficiently severe to act as a warning against infringement.

THE attention of all interested in the study of philology, comparative folk-lore, and cognate subjects, should be directed to a magazine which is now being published at Kandy in Ceylon. It has just completed its first year, and is called the *Orientalist*, the sub-title being "a monthly journal of Oriental literature, arts and sciences, folk-lore, &c." It is edited by a Singhalese gentleman, Mr. Goonetibleke, and its contributors are for the most part Singhalese. The last three numbers of the first volume are now before us, and among the contents we observe articles "on the terms of relationship in Singhalese and Tamil," the influence of the Portuguese and Dutch on these two languages, contributions to a descriptive catalogue of Sanskrit, Pali and Elu works extant in Ceylon, the progress of the Singhalese in literature, arts, and sciences. But folk-lore has, so far, been the strong point of the new magazine; it has published numerous articles on Singhalese proverbs and folk-lore; sometimes a popular tale amongst a particular Eastern people is started by a contributor, and is then pursued through other peoples having a parallel tale. These tales are translated in full, and are frequently accompanied by the originals. The address of the editor is Trincomalie Street, Kandy, Ceylon, and Messrs. Trübner are the agents for Europe.

WRITING to the *Times* on the subject of *Edelweiss*, Mr. Burbidge, of the Trinity College Botanical Gardens, Dublin, points out that the plant is easily grown in English gardens from seed. It is sown in common garden earth in a cold frame, and when large enough each little plant is placed in a small pot in a mixture of loamy earth and old lime rubbish, or the plants, he says, are equally well pleased by a niche in a sunny rock garden, provided a supply of their favourite lime rubbish or old mortar be afforded them. Contrary to the generally received opinion, the *Edelweiss* is really a plant of extremely easy culture from seeds as here directed, and, further, good fresh seeds of it are quite readily obtainable from the usual sources of seed supply.

WE have received the first number of the *Bulletin* of the Society of Natural History of Brookville, Indiana, an association organised in 1881, according to the report, with excellent results in an enlarged interest in the study of nature, the establishment of a valuable museum, and the founding of a large and excellent library. Amongst the contents we notice papers on the stone mounds on the Whitewater; on the flora, fossils, and land and fresh-water mollusca of Franklin County, and on the fauna changes of the same district. The last paper is especially interesting, as showing the effects on the fauna of civilisation and its accompaniments, such as draining, cutting down forests, &c.

WE have received the fifteenth annual report of the Wellington College Natural Science Society. The observations conducted by the society have been carried on as usual, and the more important of them are published in detail; beyond this the report offers no new features for special comment.

WE notice in the issue of the St. Petersburg *Izvestia* (xx. 6) two papers by MM. Popoff and Karatanoff on the customs of the Katchin Tartars of Minusinsk, with a notice, by M. Potanin, on wild plants used as food in Siberia. These last are numerous. The Katchin Tartars eat the grains of *Fagopyrum tataricum*; in the government of Irkutsk, during years of scarcity, the peasants add to their flour the *Polygonum convolvulus*. In Northern Mongolia the grains of *P. viviparum* (*oorgene* with the Mongols) are a common addition to food. The "ibseck," used by the Katchin Tartars, seems to be the *Cirsium acaule*, whose roots are eaten in Northern Mongolia. In Northern Siberia (Turukhansk, Yakutsk regions) the inhabitants eat the anti-scorbutic roots of the *Cochlearia sisymbroides*, Dec., var. *Czekanowskiana*, (Trautvetter). The exact determination of this plant is due to Czekanowski's expedition, for Middendorff had confounded it with the poisonous *Veratrum lobelianum*, Bernh., and he even saw in its eating a proof for the disparition of poisonous qualities of certain plants in a northern climate. When there is no pine-trees the Yakutes used to add to their sour milk a flour of dried roots of *Butomus umbellatus* instead of pine-bark. Great stores of these roots are usually made by Yakutes, who also use the grains of *Plantago media* and *P. canescens*, Adams. In the Khangai, M. Potanin was also shown a species of *Plantago* the fruits of which are eaten by the Khalkas Mongolians; but altogether, he observes, a confounding of *Polygonum* with *Plantago* has possibly been made by previous authors. We may add to this list that the *Lilium martagon* is eaten in large quantities in Transbaikalia, and that it is a common thing with the Buriates to pillage in the autumn the provisions of bulbs of this Lily made by the Arvicolæ, and to appropriate these provisions for themselves.

THE Stokes-Watson spark apparatus for showing the combustion of metals under the microscope, by the passage of the electric spark through them, made by Messrs. Watson and Sons, of High Holborn, from the design suggested by Prof. Stokes, was exhibited by Messrs. Watson at the *conversazione* of the Royal Society, Burlington House, on May 6, and again by them on Friday, June 5, at the Royal Institution. It is a most interesting apparatus, the different metals in combustion showing beautiful colours, and as the apparatus can be added to any ordinary microscope, no doubt it will become very popular.

THE Trilobites recently found in Eastern Siberia belong, according to Prof. Friedrich Schmidt, to very different ages. Those found in boulders on the Olenek (*Agnostus*, *Olenus*,

Anomocaxe) belong to the Cambrian, and are closely akin to those collected by Richthofen in China. From the Lower Silurian, the *Chasmops* of the Podkamennaya Tunguska is especially worthy of notice. It belongs to the Trentock level, as far as we may judge from corals from the same locality described by Prof. Lindström. Finally, Mr. Schmidt has received from Krasnoyarsk several samples of a new genus, the *Proetus*, which is closely akin to species from the sub-divisions F and G of Barrande.

THE additions to the Zoological Society's Gardens during the past week include a Barbary Ape (*Macacus inuus* ♂) from North Africa, presented by Capt. A. B. Hawes; two Common Badgers (*Meles taxus*) from Staffordshire, presented by Col. E. M. M. Buller; a Red Brocket (*Cariacus rufus* ♂) from Para, presented by Mr. H. E. Weaver; two —— Fruit Pigeons (*Carpophaga* ——) from the Samoan Islands, presented by Mr. T. H. Bowyer Bower, jun.; a Common Cuckoo (*Cuculus canorus*), British, presented by Mr. G. Lyon Leith; two Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, presented by Mr. L. W. Buller; a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from West Africa, deposited; a Red-vented Parrot (*Pionus menstruus*) from South America, purchased; a Molucca Deer (*Cervus moluccensis*), a Thar (*Capra jemlaica*), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *JULY* 5–11

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 5

Sun rises, 3h. 53m.; souths, 12h. 4m. 17·6s.; sets, 20h. 15m.; decl. on meridian, 22° 46′ N.: Sidereal Time at Sunset, 15h. 11m.

Moon (at Last Quarter) rises, 23h. 25m.*; souths, 5h. 45m.; sets, 12h. 16m.; decl. on meridian, 3° 2′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 30	12 45	21 0	23 19 N.
Venus	5 13	13 16	21 19	21 28 N.
Mars	1 39	9 47	17 55	22 15 N.
Jupiter	8 25	15 27	22 29	11 19 N.
Saturn	2 55	11 5	19 15	22 32 N.

* Indicates that the rising is that of the preceding day.

July	h.	
9	21	Mars in conjunction with and 5° 7′ north of the Moon.
10	23	Saturn in conjunction with and 4° 7′ north of the Moon.

GEOGRAPHICAL NOTES

IN concluding his notes on the Kurile islands, to the first instalment of which we have already referred, Prof. Milne has some interesting observations on the geology of this little known archipelago. The two islands, Iturup and Kunashiri, he says, form the two first of the series of stepping stones which connect Japan by means of Kamtschatka with Asia. They seem also to be the older members of the group. They contain a greater proportion of rounded hills and of deeply cut valleys than any of the islands farther north, and may therefore be regarded as older than those which are built up almost entirely of finely formed volcanic cones. The neighbouring island of Urup presents appearances similar to these two. He is inclined to think the formation of an island like Iturup commenced as a number of volcanic peaks forming islands, and that these have been subsequently united by elevation, indications of which there are in the stratified rocks and terrace formations. All the appearances, however, which he has ascribed to a raising of the land, might, he observes, be also explained by a raising and lowering of the sea, such, for instance, as that which Mr. Croll points out, might be produced by the accumulation of ice during a glacial period at the pole; and the fact that the height of the terraces increase as we go northwards appears to confirm this view. The steepest slope which he has observed in any portion of a volcanic cone was that of a small cone rising from the upper crater of Cha-cha-nobori, which had an inclination of 37°. This would indicate that it was formed of extremely fine materials, and that the last eruption by which these materials were formed had not been very violent.

IT is announced from Lisbon that the Portuguese explorers, Capello and Ivens, who left Loanda some time ago, have discovered the sources of the Lualaba, Luapula, and Chambeze, the upper waters of the Congo.

AMONG the recent scientific missions ordered by the French Minister of Public Instruction we find the following:—M. Bordas, to study the zoology of the Madagascar Islands, of the Seychelles, and Comoros; M. Clermont-Ganneau, to examine the epigraphy of the islands in the Red Sea, situated at the entrance to the Gulf of Akaba; M. Morgan, mining engineer, on a geological and mineralogical mission in the Orange Free State, the Transvaal, Zululand, and Natal; Lieut. Palat, to explore the route from Senegal to Algeria by Medina, Timbuctoo, Mabrouk, and the Touat.

THE island in the North Pacific which appears now to be definitely added to the British Empire is not, as was at first supposed, Quelpaert, but another Corean island, or rather group of islands, known as Port Hamilton, about forty-five miles to the north-east of the former, and about thirty miles off the Corean coast, in the Broughton Channel, separating the peninsula from Japan. The position of the group is 34° 1′ 23″ N. lat., and 124° 57′ 30″ east of Paris. The port is surrounded by three larger islands, and several smaller ones. The largest of all is on the west, and runs from north-west to south-east; it is hilly, but the height of the main eminence is not given by Sir Edward Belcher. Between the two main islands is Observatory Island, and the whole inclose an excellent harbour. The islets, except in one or two channels, which serve as entrances to the bay, are connected by barriers or reefs, above which the water is shallow. The islands are poor in wood, but water is good and abundant, and the sea abounds in fish. There are no cattle, but pigs, fowls, and some vegetables are found. The group was visited in 1846 by Capt. Belcher, and in 1855 by a French frigate.

AT the last meeting of the Geographical Society of Paris Baron Benoist-Méchin described a recent journey in the Merv oasis. This was a continuation of previous communications to the Society of the great journey made by the Baron and some companions from Peking through Manchuria, thence through Siberia, south to Samarkhand, Merv, and so into Persia. M. Simonin made a communication on the pictorial writing of the North American Indians; it appears that, of all the tribes, only the Cherokees and the Creeks possess a writing. The former have newspapers and books in their language, and write with seventy-seven phonetic characters in a syllabary invented by a Cherokee in 1830. The Creeks have nineteen characters. The notorious Sioux chief, Sitting-Bull, has written his autobiography in pictorial writing. His "Cæsar's Commentaries" are written on the back of a book which belonged to the Commissariat of the Third United States Infantry Regiment, and contain a recital of his adventures between 1864 and 1870. Each figure is roughly traced in ink, the men and horses being represented as a child might draw them; colours have in some cases been added to render the picture more vivid. The *Comptes Rendus* also contains the continuation of a paper by M. d'Aoust on the causes of earthquakes, and the itinerary of a journey in the basin of the Ruovuma by M. Angelvy, an engineer in the service of the Sultan of Zanzibar.

THE latest *Bulletin* (9me année, No. 2) of the Royal Geographical Society of Belgium is mainly occupied by a paper by M. Hennequin on the agricultural maps of Belgium, with reference to certain maps recently produced by the military cartographic institute for the Ministry of Agriculture. A brief account of Guatemala by M. Leclercq is compiled from the official publications of that republic, and a paper by M. Haron on the commune of Manage (Hainaut) is an interesting study in local geography. It deals, under successive divisions and subdivisions, with the commune on four main heads—physical, economical, and political geography.

THE last *Zeitschrift* of the Berlin Geographical Society contains the following papers:—The conclusion of "Achelis's" article on the methods and task of ethnology; rivers and lakes

as the products of climate, by A. Woeikof, and a map of Paul Acherson's journey in the Libyan desert, with the accompanying descriptive account of the journey.

A LONG-DELAYED letter from the Bishop of Central Oceania gives, *Science* states, details of the honours rendered by the civil and religious authorities to the relics of the companions of La Pérouse. These last survivors of that unfortunate expedition were massacred by the Samoans on the Islet of Tutuila on December 11, 1787. Father Vidal, of the mission, had been searching twelve years for the remains, which were finally identified in October, 1882. The authorities in France, on being notified, caused a beautiful mortuary tablet to be prepared, and forwarded to the admiral on duty at that station. A monument was erected, upon which the tablet was fixed, and a small chapel built near it. The whole was dedicated by Bishop Lamaze and Commandant Fournier, of the French Navy, with solemn ceremonial and minute-guns on the ninety-seventh anniversary of the event.

LIQUID FILMS[1]

THE molecules in the interior of a liquid are surrounded on all sides by others which they attract, and by which they are themselves attracted, while those on the surface have neighbours on one side only. In consequence of this difference in their surroundings there is in all probability a difference in the grouping of the interior and exterior molecules which is attended by corresponding variations in the physical properties of the liquid of which they are constituent parts. Thus it was shown by M. Plateau that the viscosity of the surface of a liquid is in general different from that of its interior. The most striking example of this phenomenon is afforded by a solution of saponine. Two per cent. of this substance dissolved in water does not effect any marked change in the properties of the great mass of the liquid, but produces a most remarkable increase in the surface viscosity, so that forces which suffice to create rapid motion in bodies which are completely immersed, fail to produce any appreciable movement if they lie in the exterior surface. The first attempt to obtain a numerical estimate of the difference of the resistances experienced by a body oscillating in turn in the interior and in the surface of the liquid was made about two years ago by Messrs. Stables and Wilson, students in the Yorkshire College. In the case of a horizontal disc suspended in water, the logarithmic decrement diminishes to about one half as the surface is approached. In a saponine solution, on the other hand, it is 125 times greater in the surface than in the interior, and about 38 times greater in the surface than at a depth of 0·1 mm. below it. Even in the latter case the greater part of the resistance is due, not to the friction between the disc and the liquid, but to that experienced by the supporting rod in the surface, so that in all probability the surface viscosity is more than 600 times greater than that of the mass of the liquid.

The immense change in the resistance which takes place when the disc is immersed to a depth of 0·1 mm. only confirms the general opinion that any peculiarity of grouping or arrangement due to proximity to the surface extends to a very small depth. A liquid must thus be conceived as surrounded by a very thin layer or skin, the properties of which are different from that of the liquid in the interior, and to which rather than to any ideal geometrical boundary the term "surface" might be applied. It may, however, prevent confusion if it is called the *surface-layer*.

Many attempts have been made to measure the thickness of the surface-layer. In particular, M. Plateau studied a thinning soap film with a view of determining whether or no the pressure exerted on the enclosed air by the film when very thin is the same as when it is comparatively thick. Had any such difference been observed it might have been taken as *primâ facie* evidence that the tenuity was so great that all the interior portions of the film had drained away, and that the thickness did not exceed that of the two surface-layers.

This experiment has been criticised by Prof. Reinold and myself, but it is not intended in this lecture to enter upon the general question of the thickness of the surface-layer, or the interesting theoretical problems which are closely connected with it, as we are at present engaged in an investigation which we hope may throw further light upon the subject. There are, however, two preliminary questions on which we have arrived at definite conclusions.

[1] Lecture at the Royal Institution by Prof. A. W. Rücker, M.A., F.R.S.

In any experiments which have for their object the detection of small changes in the properties of a soap film as it becomes thinner, it is essential that we should be able to assert with certainty that no causes other than the increasing tenuity have been in play, by which the effect looked for might either be produced or masked. Changes in the temperature or composition of the film must especially be prevented.

The liquid ordinarily employed for such investigations is the "liquide glycérique" of M. Plateau. In dry air some of the water of which it is in part composed would evaporate, while in moist air, in consequence of the hygroscopic properties of the glycerine, additional water would be absorbed. Though these facts were well known, and though they are evidently possible sources of error, no attempt (as far as I am aware) had been made before our own to determine what precautions it was necessary to take to prevent the results of experiments such as M. Plateau's being affected by them. The first question then that we set ourselves to answer, was—to what extent is the composition of a soap film altered by changes in the temperature or hygroscopic state of the air which surrounds it?

The method adopted in answering this inquiry was to measure the electrical resistance of soap films formed in an inclosed space containing a thermometer and hair hygrometer. If the observations led to the conclusion that the resistance of film varied inversely as its thickness, they would prove that no change in composition had taken place, and that the film at the thinnest had afforded no evidence of an approach to a thickness equal to that of the surface-layers. If the specific resistance was found to vary according to some regular law as the thickness altered, there would be a strong presumption that the thickness was not much greater than, and was possibly even less than that of the two surface-layers. If, lastly, the changes were irregular, they might safely be ascribed to alterations in temperature or constitution.

To obtain the desired facts it was necessary (1) to devise a method of forming the films in a closed chamber, (2) to measure their thickness, and (3) to determine their electrical resistance.

The films were formed in a glass box at the lower extremity of a platinum ring which communicated by means of a tube with the outside. In the earlier experiments a cup of the liquid was raised by rackwork to the ring and then withdrawn, leaving a film behind it. The latter was blown out by air which had been dried and passed through tubes containing "liquide glycérique." When large enough it adhered to a second platinum ring placed vertically below the first, and on some of the air being withdrawn it assumed the cylindrical form.

The thickness was measured by means of the colours displayed, two independent determinations being obtained by two beams of light incident at different angles. Newton's Table of Colours was revised, and it was found that the differences between the thicknesses given by him and those determined by new experiment were far greater than the error of experiment of a single observer. Hence, if accurate measurements are required by means of Newton's scale, every experimenter must reconstruct that scale for himself.

At first the electrical resistance was determined by means of Wheatstone's bridge. The edges of the film where it is close to its solid supports are often, however, the seat of phenomena which might affect the results. Thin rings of white or black appear which alter the resistance considerably, and which introduce errors for which it is almost impossible to make any accurate allowance. This fact, combined with the advantage of avoiding errors due to polarisation, and of being able to select any particular part of the film for examination instead of the whole, led us to adopt a different method. Gold wires attached to a movable support were thrust into the film, and the difference of potential between these when a current was passing through the film was compared with that between the extremities of a known resistance included in the same circuit.

The result of these observations was to prove that the specific resistance of the films altered in an irregular manner, varying between 200 and 137 ohms per cubic c.m. A closer inspection showed that abnormal results were always accompanied by abnormal variations in the thermometer or hygrometer. When those films were selected which had been observed when such variations were especially small, it was found that the range of variation of the specific resistances was only between 137 and 146, and that the mean value was 143, that of the liquid in mass being 140·5 (at the same temperature). It was also proved that between thicknesses varying from 1370 to 374 millionths of a

millimetre, no regular change in specific resistance could be detected, the actual variations lying within 2·5 per cent.

The conclusion was thus arrived at that the specific resistance of the liquid of which a soap film is formed does not differ from that of the same liquid in mass, at all events when the thickness is greater than 374×10^{-6} mm., and that comparatively small changes in the temperature or hygroscopic state of the air in contact with the film are attended with great alterations in the specific resistance, which indicate a considerable change in composition.

The method of experiment made it possible to determine the amount of this change. Solutions were made up representing "liquide glycérique" which had lost or gained given percentages of water, their specific resistances were determined at various temperatures, and approximate formulæ obtained by which the percentage of water present could be calculated if the specific resistance and temperature were known.

The results of the application of this method of analysis to a film are shown in the accompanying figure. The abscissæ represent time, the ordinates of curve I. represent the average thickness of the film. It will be observed that the film continued to get thinner during the whole time that it was under observation. The electrical observations, however, proved that at first the product of the resistance and thickness steadily increased, indicating a continuous loss of water. Curve II. shows the number of parts of water in 100 of the solution lost

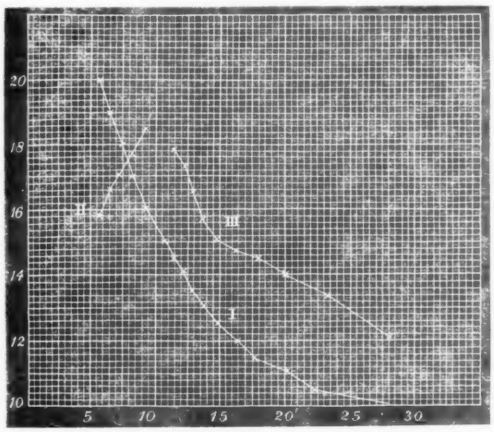

Fig. 1

at the times indicated by the abscissæ. After a while a piece of blotting paper which had been hung up inside the case was moistened with water. While this was being done the observations were interrupted. On their renewal it was found that although the film thinned as steadily as before, the product of the resistance and thickness diminished instead of increasing. Curve III. shows the steady absorption of water which followed the moistening of the air. These experiments proved that it is possible for a film to undergo great changes in composition without any indication of the fact being afforded by the colours it displays. They show that if the composition of the "liquide glycérique" is to be kept constant, all change in the temperature and hygrometric state of the air must be as far as possible prevented. In later experiments this condition has been secured by placing the film box in the centre of a water tank, and by keeping an endless band of linen hung up within the case, and which dips into the liquid, continually moistened. Observations made with this apparatus show that these precautions which are certainly necessary are also sufficient.

The second point to which special attention has hitherto been given by Prof. Reinold and myself is the measurement of the thickness of very thin films. If the thickness is less than a certain magnitude, the films appear black, and thus their colour gives only a limit to and not a measure of their thickness. Black films display many remarkable properties. In general there is a sudden change in thickness at the edge of the black indicated by the omission of several colours, or sometimes of one or two orders of colours. It is only under rare conditions that a gradual change in thickness can be observed from the white to the black of the first order.

To determine the thickness of the black its resistance was measured, and the thickness calculated *on the assumption that the specific resistance was the same as that of the liquid in mass.*

The observations were made in several different ways and proved that the thickness of the black portion remains constant in any given film, however much its area may alter. Thus, in the case of a group of films measured by Wheatstone's bridge, the average resistance of a black ring 1 mm. in breadth was 1·761 megohms when the total breadth was 2 mm., and 1,761 megohms when the total breadth lay between 10 and 12 mm.

Again, the resistance of the part of the film between the needles used in the electrometer method was practically the same when the black had extended over the whole film (40 mm. long) as it had been when only the upper 11 mm. were black. The final measurement differed from the mean by only 0·1 per cent. Again, in another film the resistance of the black per millimetre remained the same to within 2·5 per cent. for an hour and a half.

On the other hand the experiments also proved that the thickness of the black was different in different films. The values found varied between $7{\cdot}2 \times 10^{-6}$ and $14{\cdot}2 \times 10^{-6}$ mm. These differences are quite outside the possible error of experiment. If they were due to changes in the constitution of the liquid of which the films were formed, it is very improbable that the specific resistance of individual films would not have shown progressive changes. As has been stated, none such were observed. The mean thickness of the five films made of "liquide glycérique" which were observed was $11{\cdot}9 \times 10^{-6}$ mm., while that of thirteen films made of soap solution without any glycerine was $11{\cdot}74 \times 10^{-6}$ mm.

The assumption made in these calculations that the specific resistance of a film, the thickness of which is ten or twelve millionths of a millimetre, is the same as that of the liquid in mass, is not justified by the previous experiments, which had proved it to hold good only to the much greater thickness of 370×10^{-6} mm. It was therefore desirable to check the results by an independent method. For this purpose fifty or sixty plane films were formed side by side in a glass tube which was placed in the path of one of the interfering beams in a Jamin's Interferential Refractometer. The compensator was adjusted so that it had to be moved through a large angle to cause one interference band to occupy the position previously held by its neighbour, *i.e.* to alter the difference of the paths of the interfering rays by one wave-length. This angle was determined for the red light of known wave-length transmitted by glass coloured with copper oxide. When the films had thinned to the black they were broken by means of a needle which had been included in the tube along with them, and which was moved, without touching the tube, by a magnet. The rupture of the films produced a movement of the interference fringes which was measured by the compensator, and from which, in accordance with well-known principles, the thickness of the films could be deduced.

The mean thickness given by seven experiments on films made of "liquide glycérique" was $10{\cdot}7 \times 10^{-6}$ mm., that obtained from nine experiments on films made of soap solution was $12{\cdot}1 \times 10^{-6}$ mm. The mean of these, or $11{\cdot}4 \times 10^{-6}$ mm., differed only by $0{\cdot}4 \times 10^{-6}$ mm., from the mean thickness deduced from the electrical experiments.

The last point to which reference is necessary is one which lies outside the main line of the enquiries above described, but which is nevertheless not without interest. In the course of the observations it was noticed that the rate of thinning of a film seemed to be affected by the passage of the electric current through it. Some experiments made on this point last year proved the fact beyond the possibility of doubt. The current appears to carry the matter of the film with it, so that it thins more rapidly if the current runs down, and less rapidly if the current runs up than if no current is passing. This may be shown as a lecture experiment.

A vertical rod which can be moved up and down by rackwork is passed through the centre of the cover of a glass film-box. To the lower extremity is attached a horizontal platinum wire, from which another similar horizontal wire is suspended by two silk fibres. A film is formed by lowering the whole into the liquid with which the lower part of the vessel is flooded. The

light reflected from the film is passed through a lens, and an image formed upon a screen. When the bands of colour are seen descending from the upper part of the film, a current from fifty Grove's cells is passed through it. If the current flows downwards the bands of colour move more quickly than before; if it flows upwards their motion is checked and they begin to ascend. The cause of this curious fact is still unknown. It may either be analogous to the phenomenon known as the "migration of the ions," or it may be a secondary effect due to a change in the surface tension.

The general relation of the results attained by these investigations as to the question of the size of molecules is interesting. Sir William Thomson has expressed the opinion that 2×10^{-6} mm. and $0·01 \times 10^{-6}$ mm. are superior and inferior limits respectively to the diameter of a molecule. Van der Waals has been led, from considerations founded on the theory of gases, to give $0·28 \times 10^{-6}$ mm. as an approximate value of the diameters of the molecules of the gases of which the atmosphere is composed. The number of molecules which could be placed side by side within the thickness of the thinnest soap film would, according to these various estimates, be 4, 26, and 720 respectively. The smallness of the first of these numbers, especially when it is remembered that the liquid used on some occasions was of a highly complex character, containing water, glycerine, and soap, points to the conclusion that the diameter of a molecule is considerably less than 2×10^{-6} mm.

THE FAUNA OF THE SEASHORE [1]

THE marine fauna of the globe may be divided into the littoral, the deep-sea, and the pelagic faunas. Of the three regions inhabited by these faunas, the littoral is the one in which the conditions are most favourable for the development of new forms through the working of the principle of natural selection. As Prof. Lovén writes, "The littoral region comprises the favoured zones of the sea where light and shade, a genial temperature, currents changeable in power and direction, a rich vegetation spread over extensive areas, abundance of food, of prey to allure, of enemies to withstand or evade, represent an infinitude of agents competent to call into play the tendencies to vary which are embodied in each species, and always ready by modifying its parts to respond to the influences of external conditions." It is consequently in this littoral zone where the water is more than elsewhere favourable for respiration, and where constant variation of conditions is produced by the tides, that all the main groups of the animal kingdom first came into existence; and here also, probably, where the first attached and branching plants were developed, thus establishing a supply of food for the colonisation of the region by animals.

The animals inhabiting the littoral zone are most variously modified, to enable them to withstand the peculiar physical conditions which they encounter there. Hence the origin of all hard shells and skeletons of marine invertebrata, various adaptations for boring in sand, the adoption of the stationary fixed condition, and similar arrangements. Almost all the shore forms of animals, however inert in the adult condition, pass through in embryological development free-swimming larval stages which are closely alike in form for very widely different groups of animals. Thus the oyster and most other mollusca of all varieties' and shapes when adult develop from a free-swimming pelagic trochosphere larva, and so do many annelids. Such larvæ cannot be of subsequent origin to the adults of which they are phases. If such were the case, they would not have become so closely alike in structure. In reality they represent the common ancestors from which all the forms in which they occur were derived, and as all these larvæ are pelagic in habits and structure, it follows that the inhabitants of the shores were derived from pelagic ancestors. The earliest plants were also probably free-swimming.

In the case of the cirripedia there can be no doubt, from the history of their development, that they were originally pelagic, and have become specially modified for coast life; and in the case of the echinoderms the only possible explanation of the remarkable similarity of the larval forms of the various groups of widely differing adults is that these pelagic larvæ represent a common ancestor of the group. The madreporarian corals all spring from a pelagic larvæ. The colonial forms probably owe their origin and that of their skeletons to the advantage gained by them in the formation of reefs, and the increase in facilities of respiration consequent on the production of surf. In the deep sea they are very scarce.

The vertebrata are sprung from a very simple free-swimming ancestor, as shown by the ciliated gastrula stage of Amphioxus. The ascidians afford another evident instance of the extreme modification of pelagic forms for littoral existence.

The peculiar mode of respiration of vertebrata by means of gill-slits occurs in no other animal group except in Balanoglossus, which will probably shortly be included amongst vertebrata. Possibly gill-slits as a respiratory apparatus first arose in a littoral form, such as Balanoglossus, and hence their presence at the anterior end of the body, that nearest to the surface in an animal buried in sand. The connection of Balanoglossus with the echinoderms through Tornaria is very remarkable. Possibly Amphioxus once had a Tornaria stage, and has lost it just as one species of Balanoglossus has lost it, as Mr. Bateson has lately discovered.

The littoral zone has given off colonists to the other three faunal regions. The entire terrestrial fauna has sprung from colonists contributed by the littoral zone. Every terrestrial vertebrate bears in its early stages the gill-slits of its aquatic ancestor. All organs of aërial respiration are mere modifications of apparatus previously connected with aquatic respiration, excepting, perhaps, in the case of Tracheata, tracheæ being most likely modifications of skin-glands, as appears probable from their condition in Peripatus. The oldest known air-breathing animals are insects and scorpions, which have lately been found in Silurian strata. Prof. Ray Lankester believes the lungs of scorpions to be homogeneous with the gill-plates of Limulus. Birds were possibly originally developed in connection with the seashore, and were fish-eaters like the tooth-bearing Hesperornis.

The fauna of the coast has not only given rise to the terrestrial and fresh-water fauna; it has from time to time given additions to the pelagic fauna in return for having thence derived its own starting-points. It has also received some of these pelagic forms back again, to assume a fresh littoral existence.

The deep-sea fauna has probably been formed almost entirely from the littoral, not in the remotest antiquity, but only after food derived from the *débris* of the littoral and terrestrial faunas and floras became abundant.

It is because all terrestrial and deep-sea animal forms have passed through a littoral phase of existence, and that the littoral animals retain far better than those of any other faunal region the recapitulative larval phases by means of which alone the true histories of their origins can be recovered, that marine zoological laboratories on the coast have made so many brilliant discoveries in zoology during late years.

The lecturer concluded by appealing for assistance, in the way of subscriptions, to the funds of the Marine Biological Association of Great Britain, the object of which is to construct a marine laboratory on the English coast for the purpose of researches such as those referred to. England is at present without any such laboratory, although nearly all Continental countries possess them.

[1] Abstract of lecture at the Royal Institution by Prof. H. N. Moseley, M.A., F.R.S.

THE PHILOSOPHICAL SOCIETY OF GLASGOW

THE *Proceedings* of this Society for 1884-85 have just been issued in a volume of 408 pages, with six plates and two maps. The following are the principal contributions:—On feeling and perception of relation, by Dr. H. Muirhead, President; on the proper motions of the stars, by Prof. Grant; on the first editions of the chemical writings of Democritus and Synesius, by Prof. Ferguson; on the composition of ocean water, by Prof. Dittmar; on the regulation of the supply of water to cities and towns, by Mr. W. Key; on a shadowless gas ventilator, by Mr. George A. Buchanan; on African colonies and colonisation, by J. E. Carlyle; a memoir of the late Mr. James Napier; on a new musical instrument, by Mr. Thomas Machell; on a description of a new Rotiferon, by Mr. W. Milne; on a theory of storm-travel, by Mr. P. Alexander; on national and local precautions against cholera, by Dr. James Christie; on an air or gas thermometer, by Mr. J. J. Coleman; on some experiments on the influence of cold on the putrefactive process, by Mr. J. J. Coleman and Prof. McKendrick; on the liquefaction of air and other effects of extreme cold, and on artificial light and other phenomena of high temperature, by Mr. J. J.

Coleman; on sanitary arrangements and house-building in towns, by Mr. James Sellars; on Egyptian obelisks, by Mr. T. L. Patterson; on producing cast iron or ingot iron from crude or pig iron, by Mr. W. Gorman; on the heat-restoring gas furnace and heating by radiation, by Mr. W. Gorman; on uncertified deaths, by Dr. Glaister; on the spread of disease by manure poisoning, by Dr. E. Duncan; and on the form of the human skull, by Prof. Cleland. The two maps, prepared by Mr. Ravenstein, and presented to the Society by Mr. James Stevenson, are specially valuable as showing the most recent results of African travel.

During the session M. Louis Pasteur, Prof. Asa Gray, and Rev. John Kerr, LL.D., were elected honorary members, and Mr. George Anderson, lately M.P. for Glasgow, and now Master of the Mint, Melbourne, was elected a corresponding member. The Graham medal was awarded to Mr. E. C. C. Stanford for his researches on algin. The Society at present has 18 honorary, 11 corresponding, and 691 ordinary members, and in addition to the ordinary meetings, there are sections for architecture, chemistry, biology, sanitation and social economy, and geography and ethnology.

AN EARTHQUAKE INVENTION

WE have been requested to publish the following correspondence:—

Royal Observatory, Edinburgh, June 5, 1885

MY DEAR MR. DAVID STEVENSON,—At p. 248 of the new British Association volume for 1884 there is a section on "Experiments on a Building to Resist Earthquake Motion," which reads amazingly like your paper of twenty years ago; but yet it is not that, for your name does not enter, and they have in a way got round the letter of your invention by employing, in place of your bronze balls in shallow bronze basins, cast iron balls and cast-iron plates, "with saucer-like edges" for the lower basins; and for the upper basins, "cast iron plates slightly concave, but otherwise similar to those below."

Against such men would any patent be safe? though you may not have taken out any patent for your philanthropic invention for saving life in earthquake-persecuted countries; but the whole section is the most indubitable approval of your methods and principles that could well have been proposed by any one. Certainly it transcends anything that could have ever entered the mind of Yours ever very sincerely,

C. PIAZZI SMYTH

Edinburgh, June 11, 1885

DEAR SIR,—Very many thanks for your letter to my father pointing out the report of the British Association on earthquakes for 1884, which I had not seen. My father, from the state of his health, is unfortunately unable to take the matter up himself, but if you will permit me to publish your very interesting and well-put letter in NATURE it will give the honour of the invention to whom the honour is due. My father, who read your letter with great interest, begged to be remembered to "his old friend." In order to save you the trouble of writing again I shall assume, if I do not hear from you in a few days, that you have no objection to your letter being published.

I may mention that the balls for the Japanese aseismatic arrangements for the towers were made of cast iron, and those for the tables in the light-rooms were of gun-metal.

Yours very truly,

D. A. STEVENSON

Professor Piazzi Smyth, &c., &c.

Westford House, Droitwich, June 13, 1885

DEAR MR. D. A. STEVENSON,—Yours of the 11th has reached me here; and, as I left Edinburgh on that day, it was a happy thought of yours to say that, if you did not hear from me soon you would assume my consent to your making some public use of my letter to your worthy father. For, in so far as I wrote it at all, I am ready to stand by it before many or few.

But it was only the beginning of what might have been said; and that I trust you will have perceived, and will supply some of the remaining *notanda*, such as the B.A. man praising up the system for so decidedly relieving the ball-supported building from all the *sharp*, destructive effects of an earthquake-shock, and leaving only a gentle to-and-fro motion on the balls; —because this was so admirably illustrated on your father's experimental model at Milton House—by the ease and safety with which the model lighthouse standing on balls in basins was knocked all about the yard by men with sledge-hammers, when they struck only the lower basins, or what they were fixed on as representing solid, yet earthquake-affected, ground; but the moment they struck the base of the lighthouse taken off the basins and balls and planted on the ground, down toppled lantern and lamps with such a fracture, that no more experiments could be made that day.

Then, again, your father had duly allowed that his system would not defend from vertical earthquake-shocks, but he hoped that they would be far more rare at any one place than horizontal shocks spreading all around and far from the places of vertical action; and exactly so says the B.A. man for himself and his imitation balls and basins.

And then he concludes with that he does hope for so much alleviation to human suffering in earthquake regions from the large amount of safety that balls and basin supports for dwellings must give in a general way that seismic science will be elevated in the eyes of the people, or something to that effect. To all which of course you can perfectly agree, both in your own and your father's name. I can mention that the turning-point with him as to the practicability of the scheme was when he ascertained by rigid and calm scientific measures that the amount of absolute motion which had done the most mischief in some of the worst Italian earthquakes was not more than three inches, so that it came legitimately within the compass of the means *he* first suggested, and R.S.S. Arts duly stamped with its approval ten years ago.

Hereabouts is a different earth effect—viz. the High Street, so called, of Droitwich—going down slowly but surely to fill up the vacancies occasioned below by the ceaseless bringing up of salt-rock dissolved in water pumped by numberless steam-engines, and furnishing, it is said, half the human family with that one necessary mineral condiment, salt; and so much vapour of it is in the air that mere residence here for a time is said to cure rheumatism and other complaints, even without taking the celebrated brine baths, of ten times the saltness of the ocean itself. Yours very truly,

C. PIAZZI SMYTH

P.S.—The spectroscopic salt line D is preternaturally strong in the air here; "D" might stand for Droitwich.

SCIENTIFIC SERIALS

Journal of the Russian Chemical and Physical Society, vol. xvii. fasc. 1.—Annual reports of the Society.—On the isomerism of hydrocarbons according to the theory of substitution, by M. Menshutkin (analysed in another column).—On the preparation of hemines, by M. Schalfeyeff.—On its crystalline forms, by A. Lagorion (with plates).—Notes on an apparatus for washing precipitates; on the oxidation of aromatic amines; on the action of alcohol on diazo compounds.—On the isomerism of solutions, by W. Alexeyeff.—On the same, by D. Konovaloff.—Minutes of proceedings of the physico-chemical section of the Moscow Society of amateurs of Natural Sciences.—On the electrolytic figures of Nobili and Gebhard in the magnetic field, by W. Stchegliaeff (with a plate).—On the collision of absolutely rigid bodies, by N. Schiller, being a mathematical inquiry, to show that the invariability of the *vis viva* can be established by the geometrical determination of the absolute invariability of the systems.—On the dilatation of liquids, by K. Jouk. Researches at the University of Kieff proved that common ether, ethylic alcohol, sulphurous anhydride, diethylamine, and chloric ethyl comply with the formula $v = a + b \log (\tau - t)$.—Polemics between MM. Kraewitsch, Stoletoff, and Petroff.

Vol. xvii., fasc. 2.—Thermal data for hydrocarbon compound of bromide of aluminium, by G. Gustavson. The figures found by Berthelot, give for the molecule Al_2Br_6 a heat of dissolution equal to 170,600 units, M. Gustavson has found, from a series of six determinations, an average of 180,237 (from 179,926 to 180,763). When taking $AlBr_3\ 3(C_7H_8)$, the number of calorics received was nearly 168 (from 168,001 to 168,567).—On diallyloxalic acid, and on the preparation of oxalic ether, by E. Schatzky.—On the formation of carbonates of strontium, barium, and calcium, by J. Bevad, being an inquiry into the rapidity of reactions.—On the change of colours of coloured surfaces under artificial light, by Th. Petrushevsky.

Sitzungsberichte der Naturwissenschaftlichen Gesellschaft Isis, Dresden, 1884.—Osteology of *Rana temporaria*, L., and *Rana esculenta*, L., by H. Reibisch.—Note on *Testudinaria elephantipes*, Lindl., and *Welwitschia mirabilis*, Hook, by Prof. O. Drude.—Biographical notices of the late Dr. H. R. Göppert of Breslau, of F. von Hochstetter of Vienna, and of Dr. W. Gonnermann of Coburg, by Dr. Geinitz.—Mineralogical and geological results of a journey to Italy in the year 1884, by A. Purgold.—On a prehistoric necropolis at Trög, near Rosegg, Carinthia, by W. Osborne.—On some metal objects recently discovered at Jessen, near Lommatsch, by Dr. Caro.—On the increase of accidents from lightning in the Kingdom of Saxony, by Johannes Freyberg.—Remarks on some urns and other archæological remains lately discovered at Uebigau, near Dresden, by Dr. J. von Deichmüller.—Memoirs on the phanerogamous flora of the Voigtland district, Saxony, by A. Artzt.—On the granites, gneiss, crystallised limestones, schists, and other primitive rocks occurring in the districts north of the Zittau and Jeschken ranges, by Emil Danzig.

Rendiconti del Reale Istituto Lombardo, May 7.—Results so far obtained from the study of the chief ichthiofauna of the Cretaceous period, by Prof. F. Bassani. This elaborate monograph concludes with a comparative table of the fossil fishes of Pietrarvia, Voirons, Comen, Lesina, Crespano, Monte S. Agata, Grodischtz, Tolfa, and Hakel.—A contribution to the study of etherification by double decomposition: formation of the nitrous ether of allylic alcohol, by Prof. Giacomo Bertoni.—Further remarks on the functions which satisfy the differential equation $\Delta^2 u = 0$, by Prof. Giulio Ascoli.—Remarks on the modifications introduced by the present Minister, Pessina, into the Penal Code proposed by Savelli, by E. A. Buccellati.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 18.—"Regional Metamorphism," by Joseph Prestwich, M.A., F.R.S., Professor of Geology in the University of Oxford.

Metamorphic rocks have been divided into two classes—(1) Those in which the change has been caused by contact with heated eruptive rocks; (2) Those extending over wider areas, in which the rocks are in no apparent relation to eruptive or igneous rocks. The first has been termed *Contact Metamorphism*, and the second *Normal* or *Regional Metamorphism*, the latter two terms having been used to express the same phenomena and treated as synonymous.

The author, however, for reasons to be assigned, proposes, while retaining the use of both the latter terms, to apply them differently. Normal metamorphism he would confine, as hitherto, to the changes caused by the heat due to depth, on the supposition of the existence of a heated central nucleus of the earth, while he would use the term *regional metamorphism* to denote changes effected by the agency of the physical causes to which Mr. Mallet referred the fusion of the volcanic rocks, namely, *the heat produced locally within the crust of the earth by transformation into heat of the mechanical work of compression, or of crushing of portions of that crust.*

The primary object of Mr. Mallet's experiments was to ascertain the force required to crush portions of various rocks of given size, and to determine the quantity of heat evolved by the process. For this purpose the work done was measured by the number of cubic feet of water at 32° F. that could be converted into steam of one atmosphere (or at 212° F.) by the estimated heat evolved by the crushing of 1 cubic foot of each class of rock.

With all the harder rocks the heat produced in the metal surroundings by the complete crushing was easily perceptible by the hand, and was so great with some of the granites and porphyries as to necessitate a delay for the apparatus to cool. Both Mr. Mallet and Prof. Rankine were of opinion that in the crushing of a rigid material such as rock *almost the entire* mechanical work (with the exception of a small residue of external work) reappears as heat. It was further shown that, even in the most rigid bodies, crushing begins by compression and yielding, and that at this stage heat begins to be evolved.

Consequently the work thus developed being transformed into heat, that heat will be greatest along those lines or planes at places where the movement and pressure, together constituting the work, is greatest; whence Mallet concluded that along or about such axial lines of concentrated compressive and crushing work the temperature may locally rise to a red heat, or even to that of fusing the rocky materials crushed and of the pressing-together-walls themselver adjacent to them. This was in his opinion the real nature and origin of the volcanic heat as now produced on the globe.

Although the hypothesis fails for various reasons in its application to vulcanicity, especially for the reason that the great lines of disturbances and compression of the Alps, Pyrenees, and other mountain chains are free from either active or extinct volcanoes, there is, nevertheless, reason to believe that this source of heat may have been adequate to produce great molecular changes in the rocks along the lines of disturbance and upheaval, though the extreme results obtained by entire crushing by mallet would rarely or ever occur in nature. It is, however, precisely along such lines that not only are older rocks metamorphosed, but rocks of Cretaceous and Tertiary age—which usually have not been affected by normal metamorphism—coming, in these mountain-chains, under the influence of the disturbing forces, have undergone a change analogous to that produced by normal metamorphism.

Objections have been raised to the explanation offered in some cases of alteration of sedimentary strata in mountain-chains by ordinary normal metamorphism, on the grounds that unaltered strata alternate with altered strata. Sometimes this may be explained by inversion of the strata, or, where that is not the case, it may be due to the circumstance that differences of mineral composition, or in the proportion of the water of imbibition, have caused the metamorphism to affect different beds in different degrees. On the theory of *regional metamorphism*, in the sense the author would use it, another explanation suggests itself by the way in which differences in the resistance of the rocks develop different quantities of heat. Mr. Mallet has shown by experiments on the compressibility of rocks at Holyhead that, although certain slate-rocks were compressed by precisely the same force before their elastic limits were passed, yet, owing to differences in their compressibility, the heat developed in the rocks when released would render the quartz-rock nearly three times as hot as the slate-rock. In this manner, therefore, it seems possible to account for a special and restricted metamorphism of the strata in mountain-chains, and for its frequently localised occurrence.

The remarkable changes which take place in the condition of the coal of Pennsylvania, as it ranges into the Appalachian Mountains, may also be owing more probably to *regional* than to normal metamorphism. This mountain-range consists of a series of great parallel folds increasing in acuteness as the central axis is approached. Eruptive rocks are absent, but, nevertheless, the strata as they approach the central chain become more crystalline, and the coal, which at a distance is ordinary bituminous coal, passes into anthracite and even graphite. The late Prof. H. D. Rogers divided this great coal-field into four basins. The coal in the less-disturbed district near the Ohio River, where the flexures are extremely gentle and wide apart, contains from 40 to 50 per cent. of volatile matter; in the wide basin further east it decreases to 30 or 35 per cent.; in the basins of the Alleghany range, in which, although there are no important dislocations or great flexures, there are some extensive and symmetrical anticlinal axes of the flatter form, the proportion of the volatile matter in the coal varies from 16 to 22 per cent.; while in the most easterly chain of basins which are associated with the boldest flexures and greatest dislocations, with close plications and inversions of strata, the quantity of volatile matter in the coal is reduced to 6 to 14 per cent.

A somewhat analogous instance is presented by the Carboniferous series of Belgium. The excessive squeezing, faulting, and inversion which the Coal-measures have undergone on the flanks of the axis of the Ardennes, is there accompanied by an alteration of the highly bituminous coals into dry coals and into anthracite; while the Carboniferous and Devonian limestones amidst the sharply convoluted and folded strata of the Ardennes are there, as they are also on the line of the same disturbance in the Boulonnais, transformed very generally into crystalline marbles. The few exposures of eruptive rocks are all on a small scale, and affect the adjacent rocks only by contact metamorphism. It is probable that the anthracite of South Wales is the result of similar *regional metamorphism.*

In the case of contact metamorphism the changes were produced by great heat, for the eruptive rocks must have had a temperature of 3000° to 4000° F. or more; while in the case of normal metamorphism it is evident that the changes produced

did not depend so much on high temperature as on pressure or the presence of water, and there is reason to believe that a temperature of about 600° to 800° F. would suffice to produce all or almost all the observed hydrothermal effects. For although in many instances of normal metamorphism new minerals are formed, the rocks are not fused, nor are the fossils destroyed. In Brittany, black slates which pass into schists with large crystals of chiastolite still show impressions of *orthis*, *trilobites*, and other Silurian fossils. Devonian strata in the Vosges pass into a rock consisting of pyroxene, garnet, epidote, &c., and yet retain impressions of *corals*.

Of the enormous tangential pressure exercised in the elevation of these chains, some idea may be formed when we consider the amount of compression which those portions of the crust have undergone. Thus, for example, Heim estimates that in the Alps the compression has been to the extent of 72 miles; and in a recent paper by Prof. Claypole he arrives at the conclusion, after a careful investigation of the magnitude and width of each fold, that in the Appalachian Mounta ns "a tract of the earth's surface, measuring originally 153 miles from south-east to north-west, has been so crushed and compressed that its present breadth along the line of section is only 65 miles," and of this, in one part—the Cumberland Valley—"95 miles of country have been compressed into 16 miles."

These vast compressions could not have taken place without the transformation into heat of the equivalent amount of mechanical work, though the degree and centralisation of the heat would depend on the rapidity and completeness with which the crushing has been effected. It is not therefore surprising to find that, in some of the newer mountain-ranges, a small residual portion of the heat thus mechanically evolved may still exist and cause slight aberrations in the position of the underground isothermal lines, and the same cause may possibly account for other exceptional cases.

The only sufficiently complete set of observations on a mountain-chain of this character that have yet been made are those before alluded to by Dr. Stapff in the St. Gothard Tunnel. The author has before given, in his paper on "Underground Temperatures," particulars of these observations, and therefore here only mentions that at the north end of the tunnel in the part where an axis of elevation of late geological age (Pliocene) traverses the range, the thermic gradient, which normally equals about 57 feet for 1° F., is there not more than 38 feet; and for this Dr. Stapff states that there was no obvious explanation.

The author concludes by expressing a belief that there exists, in the compression and motion of the strata which has always accompanied the upheaval of mountain-chains, a *vera causa* for the production of an amount of heat sufficient to produce one form of metamorphic action—a form which can affect only particular regions—and he would, therefore, in order to show its distinctiveness from either *contact* or *normal* metamorphism, designate it by the term of "*Regional Metamorphism.*"

Physical Society, June 13.—Prof. Guthrie, President, in the chair.—On the winding of voltmeters, by Profs. W. E. Ayrton and John Perry. As it is most important that voltmeters, ohmmeters, powermeters, and ergmeters should be so constructed that the percentage increase of resistance of their fine wire coils due to the heating effects of the currents passing through them should be as small as possible, the question arises as to whether such coils should be made of German silver wire, or of copper, or partly of German silver and partly of copper wire, and how the diameter of the wire should vary in different parts of the coil. The authors have therefore been led to investigate the conditions that make this heating error a minimum with cylindrical coils of internal and external radii r_0 and r_1. At a place whose distance from the axis is r, let the cross-section of the wire be x_1, ρ the specific resistance of the material; then, assuming that $x = x_0 r^a$, $\rho = \rho_0 r^b$, $\rho r = \rho_0 r_0 r^c$, and that a current, C, in one spire of radius r produces a magnetic effect, KCr^d, on the supended needle, they find that the heating error is proportional to

$$r_0 \rho_0 \frac{p^2}{(r_1^p - r_0^p)^2} \cdot \frac{n}{r_1^n - r_0^n} \cdot \frac{r_1^m - r_0^m}{m},$$

where $p = d - a + 1$, $n = 2 + b - 2a$, $m = 2 + 1{\cdot}7144 b - 4a$. The conditions that make this expression a minimum are worked out in the paper, the result being that with one of their magnifying spring solenoid instruments, where $d = -1$, the values of a and b giving a minimum value are $a = 0{\cdot}325$ and $b = -0{\cdot}5$, and since in practice b cannot be negative, they conclude that $b = 0$ and $a = {\cdot}4$ give the best results—*i.e.*, that all the wire employed in the bobbin should be of copper, and the law of increase of cross-section proceeding from the centre should be $x = x_0 r^{0 \cdot 4}$. The actual waste of energy in the instruments is next considered, and, lastly, the authors show how to pass from a voltmeter with known winding, and whose maximum reading is P_1 to another of the same volume and shape whose maximum reading is to be P_2, and they conclude that, as they have shown that the waste of energy is the same in both for their maximum readings, the resistances of the instruments must be proportional to the squares of P_1 and P_2, or, following the law already arrived at for a minimum error due to heating, the cross-sections of the wires of the two instruments at similar places must be inversely proportional to P_1 and P_2. The employment of outside coils for voltmeters is considered, and it is shown that if we desire the same error in the two instruments due to heating when the outside resistance coils are of the same size and shape, it is necessary to have the same ratio between the resistance of the resistance coil and that of the magnetising coil in the two cases. To have a less or a greater error in the second case it is only necessary to use the equation—

$$e \text{(the error)} = \frac{2 + F.V}{1 + F.V},$$

where F is a constant and V the volume of the German silver resistance coil. From this V may be determined and the ratio $\frac{R_1}{R}$ of the resistances of the resistance coil and the magnetising coil is given by $\frac{R_1}{R} = \frac{F}{D} V$, where D is a constant which, like F, is obtained from experiments on the first instrument. The diminution of the heating error by using much iron in the instrument so as to obtain the same magnetic action with a much smaller current is discussed, and experiments were shown to illustrate how such employment of iron introduced a permanent magnetism error and caused the indications of such an instrument on the lower part of the scale to be uncertain and to depend upon whether measurements were being made with an increasing or a diminishing current.—On the manner in which light affects the resistance of selenium and sulphur cells, by Mr. Shelford Bidwell. In a communication made to the Society at its last meeting, the author had described a sulphur cell which behaved in all respects like a selenium cell when exposed to light. The action of this cell was supposed to be electrolytic, the sulphur containing a small quantity of sulphide of silver. If this were the case the result of a current traversing the cell would be to deposit sulphur upon the anode, and, as sulphur has an enormous resistance, that of the cell would increase unless the sulphur thus deposited combined with the silver. It is this combination that is believed to be much facilitated by light, a supposition the author believed he had confirmed by direct experiment. Mr. Bidwell had also measured the resistance of a piece of selenium that was believed never to have been heated in contact with a metal. The specimen was crystallised by heating for some time in a glass mould, two opposite sides cleaned, and two pieces of tinfoil between which the resistance was measured pressed against them. In this way the specific resistance was found to be 2500 megohms, which is enormously higher than that of the selenium in the "cell," a fact tending to confirm the theory that the conduction in such cells is due to the electrolysis of the selenides of the metals forming the terminal produced in the "cooking," and similar to that of the sulphur cell described above.—On the error involved in Prof. Quinke's method of calculating surface tensions from the dimensions of flat drops and bubbles, by Mr. A. M. Worthington. In a series of well-known papers Prof. Quinke has recorded a large number of measures of flat drops and bubbles, from which he has deduced the values of tensions for the free surface of a liquid and for the common surface of two liquids in contact. The numerical results obtained in this way exceed those obtained from observations upon the rise in capillary tubes, which Prof. Quinke attributes chiefly to the fact that in the latter case the edge angle is not zero. Mr. Worthington, however, shows that the surface tensions obtained by Prof. Quinke with flat drops are too high, this arising from his having assumed that the drops were flat at the vertex. The error thus introduced is very considerable, amounting in most cases to as much as 10 per cent. of the whole value, and upon its being duly corrected, the values obtained do not appreciably exceed those obtained with capillary tubes.—On a comparison between the mercury standards of resistance issued by M. Mascart with those of the British Association, by Mr. R. T. Glazebrook.

Anthropological Institute, June 23.—Francis Galton, F.R.S., President, in the chair.—The election of the following new members was announced.—Prince Roland Bonaparte, Lady Brassey, Miss M. North, Dr. Robert Brown, M.A., Col. Cadell, V.C., C. Heape, H. H. Johnston, D. MacRitchie, Prof. H. N. Moseley, F.R.S., C. Seidler.—Lady Brassey exhibited a collection of objects of ethnological interest from Polynesia.—Several ethnological specimens from New Ireland were exhibited by Miss North.—Mr. Carl Lumholtz exhibited a series of Australian implements.—Mr. H. B. Guppy read a paper on the physical characteristics of the natives of the Solomon Islands. In this paper the author gave the results of observations made during the years 1881–84 on the natives of certain localities in the Solomon group. The typical Solomon Island native (male) is well proportioned, with a height of about 5 feet 3 inches, a weight of 125 to 130 lbs., and a chest-girth between 34 and 35 inches, whilst the colour of his skin is a deep brown, corresponding with colour-type 35 of M. Broca. Considerable variety, however, prevails in the physical characters of these natives, and it was shown, by comparing the inhabitants of the islands of Bougainville Strait with those of St. Christoval and its adjoining islands at the opposite end of the group, that in the former locality there exists a taller, darker, and more brachycephalic race, whilst in the latter mesocephaly prevails, and the average native is rather shorter and of a lighter hue. The colour of the skin varies considerably throughout the group from a very deep brown to a light copperish hue, the range being represented by colour-types 42 and 29 with their intermediate shades. After making 109 measurements of the heads and skulls of natives in order to obtain the ratio of the transverse to the longitudinal diameter, the author arrived at the conclusion that, although mesocephaly and brachycephaly most frequently characterise these people, the form of the skull varies between too wide limits to allow of one particular type being referred to this group. The range of the cephalic indices calculated from these measurements is 69 to 86, and the greater number are gathered in two groups—one around the indices 74 and 75, and the other around the indices 79 and 80.—The following papers were also read:—On the Sakais, by Mr. Abraham Hale.—Notes on the astronomical customs and religious ideas of the Chokitapia or Blackfeet Indians, by M. Jean L'Heureux.—Observations on the Mexican zodiac and astrology, by Mr. Hyde Clarke.—On the primary divisions and geographical distribution of mankind, by Mr. James Dallas.

Entomological Society, June 3.—R. McLachlan, F.R.S., President, in the chair.—Two new members were elected.—Exhibitions: Mr. F. P. Pascoe, aërial roots of an orchid which resemble caterpillars; and a new genus and species of *Colydiidæ* from North Borneo.—Mr. G. T. Porritt, larvæ of *Phycis betulæ* and of *Coleophora currucipennella*.—Mr. R. McLachlan, a specimen of *Deiopeia pulchella* captured on board ship in the Atlantic, many miles from land.—Mr. J. W. Douglas communicated notes on an apple-tree destroyed by *Schizoneura lanigera* and *Mytilaspis pomorum*, and Mr. F. Enock read the completion of his account of the life-history of *Atypus piceus*.

PARIS

Academy of Sciences, June 22.—M. Bouley, President, in the chair.—At the opening of the proceedings the President announced the death of M. Tresca, member of the Section for Mechanics, who died on June 21, and in whom the Academy loses one of its most distinguished and active associates.—Note on Dr. Raphael Dubois' apparatus for applying anæsthetics composed of titrate mixtures of chloroform and air, by M. Paul Bert. This apparatus has been tried with the greatest success in Brussels and Ghent, and especially by Dr. Péan of Paris, who has already tested its efficiency in 400 surgical operations. The anæsthesis in nearly all cases continues perfectly regular and complete, without any interruption, even under severe operations. The pulse remains normal, the respiration easy and undisturbed, the awakening calm and natural.—On the superiority of the new "tubes à ailerons" over the ordinary smooth cylinders at present employed in tubular boilers for generating steam, by M. J. Serve. The author and inventor claims by these cylinders to have solved the problem how to produce the greatest quantity of heat with the least expenditure of fuel.—On an arrangement by which the magnetic potential due to a system of bobbins may be determined without calculation, by M. G. Lippmann.—Note on the influence of thunderstorms on underground telegraphic wires, by M. Blavier. The occasional disturbances, to which even well-protected underground wires are subject, apparently in opposition to the theory of static electricity, the author thinks may be explained either as an effect of electrodynamic induction, or as an effect of electrostatic induction.—On the molecular lowerings which constitute the limits of congelation for bodies dissolved in water, by M. F. M. Raoult.—Description of two new types of hygrometers, by M. Bourbouze.—On the transformation of sulphur: MM. Reicher and Ruys' claims of priority of invention in connection with M. Gernez's recent communications, by M. J. H. Van't Hoff.—Alkaloids produced by the action of ammoniac on glucose, by M. C. Tauret.—Action of the seleniates and selenites, and the alkaloids. A new reaction of codeine, by M. Ph. Lafon.—Note on Aseptol (orthoxyphenylsulphurous acid), by M. E. Terrant.—Contribution to the study of antiseptics. Action of antiseptics on the higher organisms. Thymic acid, by MM. A. Mairet, Pilatte, and Combemale.—On the process of fructification of the genus Callipteris, by M. Ed. Bureau.—On the infusoria by Balbiani named *Anoplophyra circulans*, by M. A. Schneider.

CHRISTIANIA

Society of Science, May 15.—Herr Worm-Müller referred to the meritorious work of the recently-deceased Danish Prof. Panum, as regards physiology as well as pathology. He further presented a paper in which he demonstrated the utility of Robert's method for the determination of sugar in animal substances when above 0·4 per cent. Finally he explained the researches made by Herr J. Otto on the functions of the sugar in the liver. He stated that they proved that the blood contained far more sugar on entering than on leaving the liver, and more than the blood in general. The researches went to support M. Bernard's experiences, viz., that the quantity of sugar formed in the liver in the course of twenty-four hours was much larger than hitherto thought.—Prof. O. Sars presented a paper: "A contribution to the Norwegian invertebrate fauna," by Herr C. A. Hansson.

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